GAS

ENGINEERING • UTILIZATION • LOAD-BUILDING • MANAGEMENT

564

DEPARTMENT OF COMMERCE
SEP - 9 1938
SAN FRANCISCO

The longer American Meter Company displacement meters and flowmeters remain in users' service, the more self-evident become the integrity, accuracy and ruggedness built into them.

AMERICAN METER CO. INC.

PACIFIC METER WORKS • LOS ANGELES • SAN FRANCISCO

1091

SEPTEMBER 1938 • • 25 CENTS

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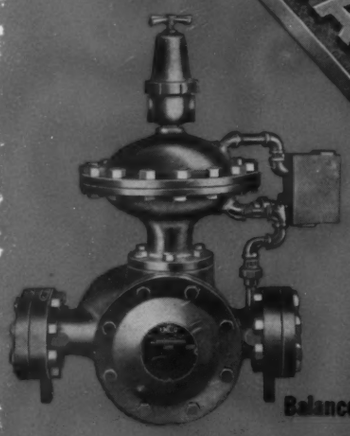
EMCO

RELIABILITY ECONOMY



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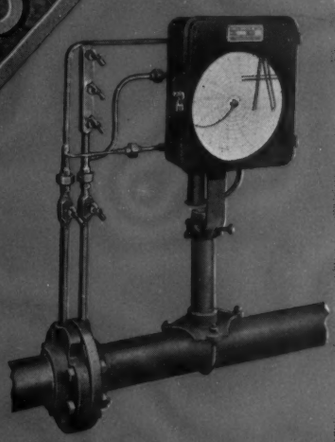
Built for either high or low pressure regulation. EMCO Regulators have the exclusive removable and interchangeable valve bowl feature, which permits repairs to be made in the line with only a slight interruption in service.

Pilot Loading or Pilot Control Systems can be readily applied to EMCO Regulators.



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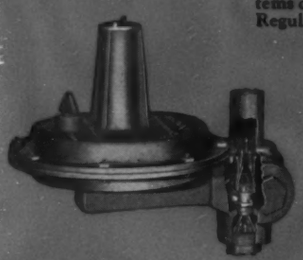
Orifice Meters

The design features of EMCO Orifice Meters include the use of stainless steel for all internal parts; entirely independent differential and static units; no angularity error; smooth, accurate differential movement obtained through the use of exceptionally large float; moisture-proof case and an all-welded steel manifold.



EMCO
Ejector Service Regulators

Especially designed and built for domestic service and will operate under high or low pressure. Increased capacity and automatic loading with a marked decrease in pressure variations is made possible through the application of the ejector principle of flow control in the regulator valve chamber.

EMCO
Domestic Gas Meters

Made in four types; the Standard, Curb Box, Tin and Ironclad. Each type is particularly qualified to fulfill the accurate measurement requirements of a specific domestic service. All are carefully constructed from the finest selected materials.

EMCO
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Made in both Spring and Lever and Weight types. Especially designed for pipe line installations where a group of consumers are served directly from a high pressure transmission line or where a single customer must be served through a long serv ice line.

EMCO Large Capacity Pressed Steel Meters equipped with EMCORECTOR

The pressed steel construction makes an extremely strong, yet light and compact, meter for large capacity measurement. They have all the inherent simplicity and accurate measurement qualities of the well known EMCO line. Built in two sizes, having maximum capacities of 6,000 and 10,000 cu. ft. per hour respectively.

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MERCO NORDSTROM VALVE CO.

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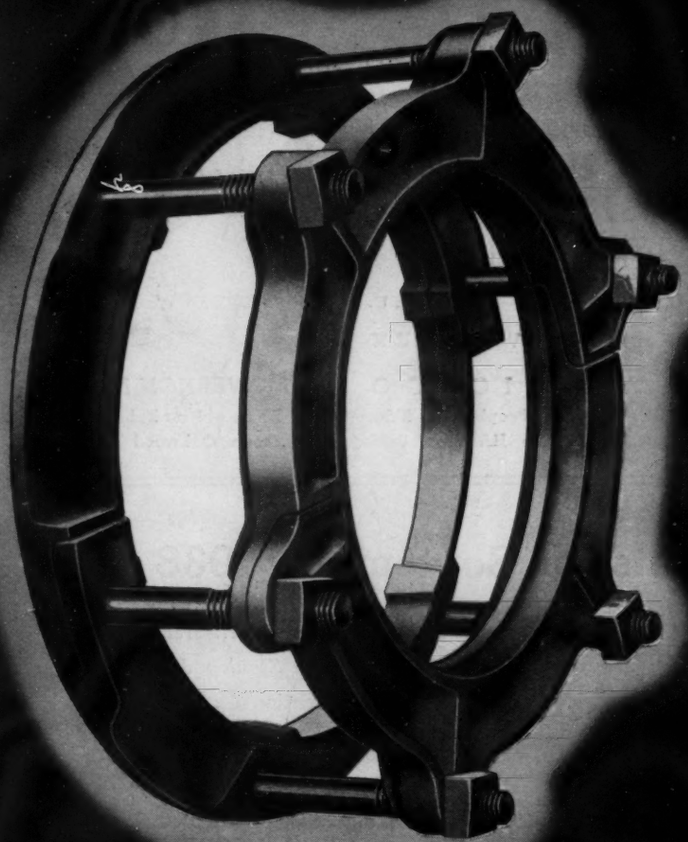

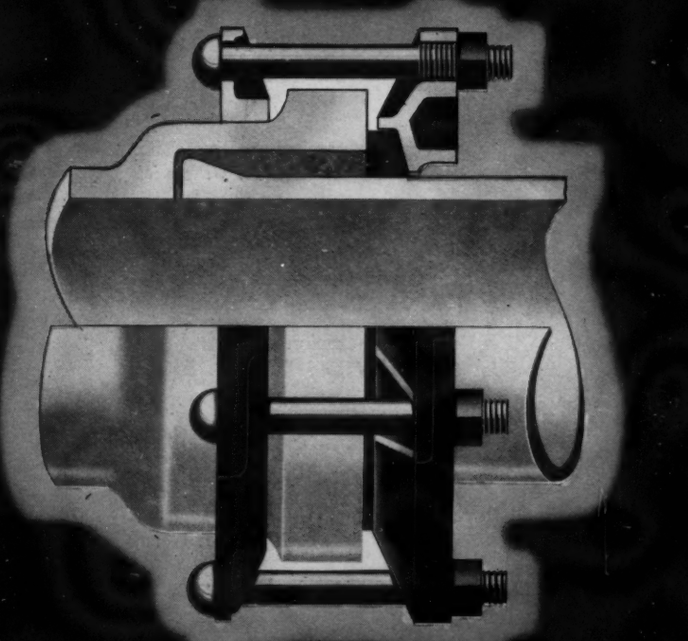

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- Simplest design of any similar clamp on the market today. Ease of application is assured.
- No adjustments are necessary. The clamp is tailored to the joint.
- Extremely heavy construction of sections to prevent any possible distortion in drawing up.
- Hand sledged for even bearing completely surrounding spigot and as a test of perfect annealing.

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(DAYTON COUPLING DIVISION)

TOLEDO, OHIO, U.S.A.

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GAS

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CLEAN GAS MAKES SATISFIED CUSTOMERS

People set their standards high nowadays — in automobiles or household appliances they won't tolerate failure. More than ever your success depends upon your ability to keep Gas flowing through their burners — smoothly, silently, surely. That's a test only CLEAN Gas can meet, especially now that appliance apertures are smaller, mechanism more delicate.

So banish the chance of burner-clogging due to fuel . . . depend exclusively upon Blaw-Knox Gas Cleaners. Operating Engineers from coast to coast are doing that . . . and experience is showing them that "as GAS flows, demand grows".

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GAS CLEANERS

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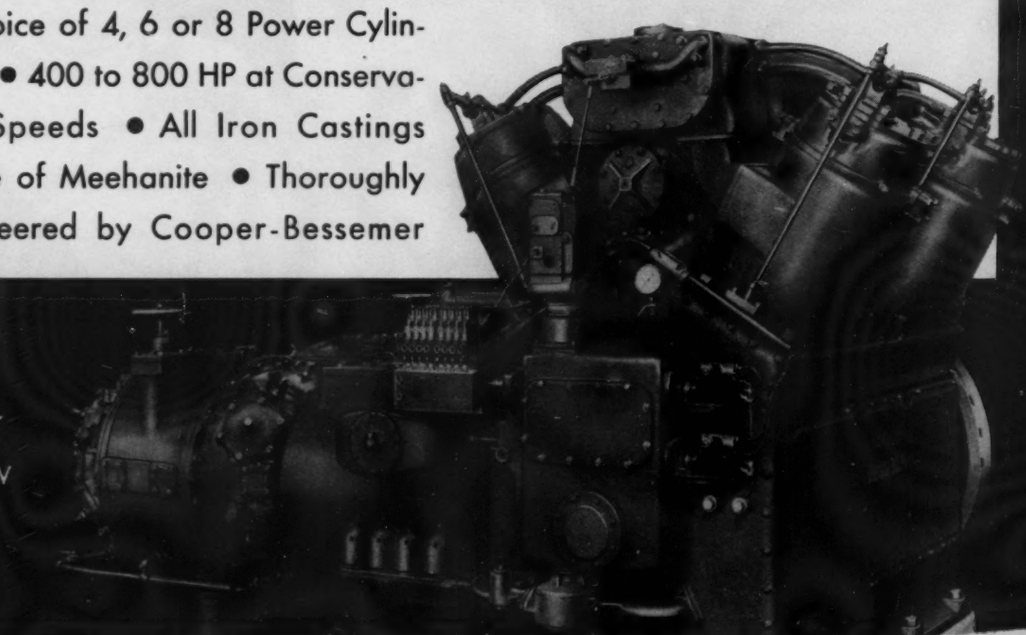
A NEW TWO-CYCLE GAS-ENGINE-DRIVEN COMPRESSOR UNIT

• Lowest Capital Investment Per HP • Most HP In Smallest Space . . . Lowest Installation Cost Consistent With Good Engineering • Smooth-Running, Balanced, V-Design • Simple 2-Cycle, Gas-Injection Type • Choice of 4, 6 or 8 Power Cylinders • 400 to 800 HP at Conservative Speeds • All Iron Castings Made of Meehanite • Thoroughly Engineered by Cooper-Bessemer



Write for the new Type G-MV Bulletin

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640 EAST 61st STREET . . . LOS ANGELES, CALIFORNIA

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IS THERE A WEAK LINK

-- IN YOUR CHAIN?

Certified Performance equipment is only the first link in the chain that leads to more profitable operation. Don't let a weak link break the chain!

Certified Performance appliances demand clean gas. It's *your* job to see that the gas you manufacture permits C. P. appliances to operate as they should. That means dependable gas manufacturing equipment, with *adequate* cleaning facilities.

So look to your gas manufacturing equipment—it may be the weakest link in an otherwise strong chain...We'll be glad to give you complete information on any of the apparatus Semet-Solvay has developed for cleaning gas.

SEMET-SOLVAY EQUIPMENT
FOR CLEANER GAS

WASHER COOLERS
Remove Tar

MULTIPLE WASHERS
Remove 90% of remaining Tar

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Leave less than 4 grains per 100 cu. ft.

GAS PURIFIERS
Remove H_2S

CONDENSORS
Cool the Gas

and

SEMET-SOLVAY
WATER GAS MACHINES
FOR LOWER PRODUCTION COSTS

Certified Performance is an old story to users of Semet-Solvay equipment. For years, Semet-Solvay has certified the performance of its equipment in advance of installation.

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ENGINEERING CORPORATION

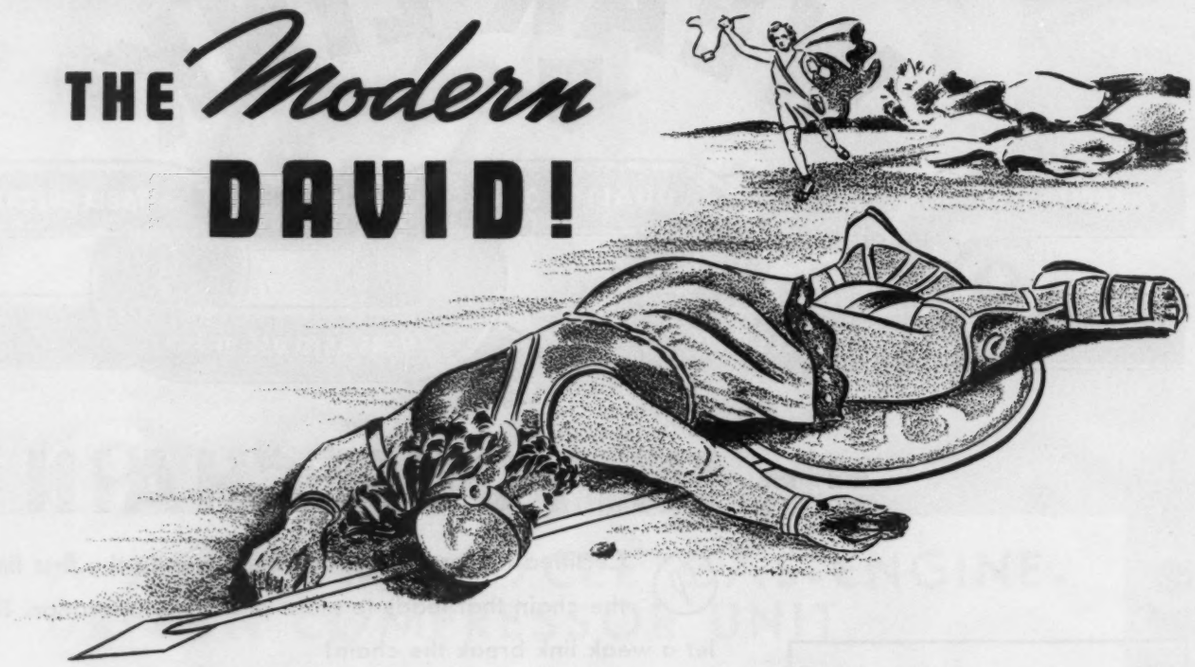
Engineers ***Contractors***

SEMET-SOLVAY ENGINEERING CORP. WE SELL SOLUTIONS TO HARD PROBLEMS NEW YORK

40 RECTOR ST. NEW YORK, N. Y.

GAS DEHYDRATION

THE *Modern* DAVID!



David was a master strategist! He felled the formidably armed Goliath with a tiny, truly aimed pebble, shrewdly realizing that Goliath was dangerous only at close range where the full force of his destructive weapons might be vented. Thus, he eliminated destruction before it could occur!

Dehydration, truly, is a modern David to gas companies plagued by the evils of internal pipe line condensation. By the simple and permanently effective means of removing water vapor from "dry" gas, *before it enters your pipe line*, dehydration eliminates the formation of hydrates and condensate in low line spots. Thus, through the consequent elimination of restrictions, your pipe line operates at the full of its rated capacity at all times, under all conditions, winter or summer. Winter worries from internal icing are eliminated since no condensate is present to form ice and, when peak loads are needed, your line can be counted on to deliver the capacity for which it was engineered.

Water in the line means formation of acids due to the presence of oxygen, hydrogen sulphide or carbon dioxide in the gas. Dehydration renders these otherwise damaging elements harmless by preventing them from combining with water. The result is longer pipe line life through elimination of internal corrosion!

Comparatively, the investment required for dehydration is as small as David's pebble and the results are equally as big. An inquiry on your letterhead will bring full information concerning methods of employing dehydration to combat internal pipe line condensation under conditions as they exist in your system. We are prepared to place at your disposal the full of our experience gained from engineering, designing and constructing dehydration plants now operating under all climatic conditions ranging from the extreme, below zero temperatures of the north to the blistering heat of the desert.

★ ★ ★

NATURAL GASOLINE PLANTS
GAS DEHYDRATION UNITS WITH CALCIUM CHLORIDE, or DIETHYLENE GLYCOL CYCLES
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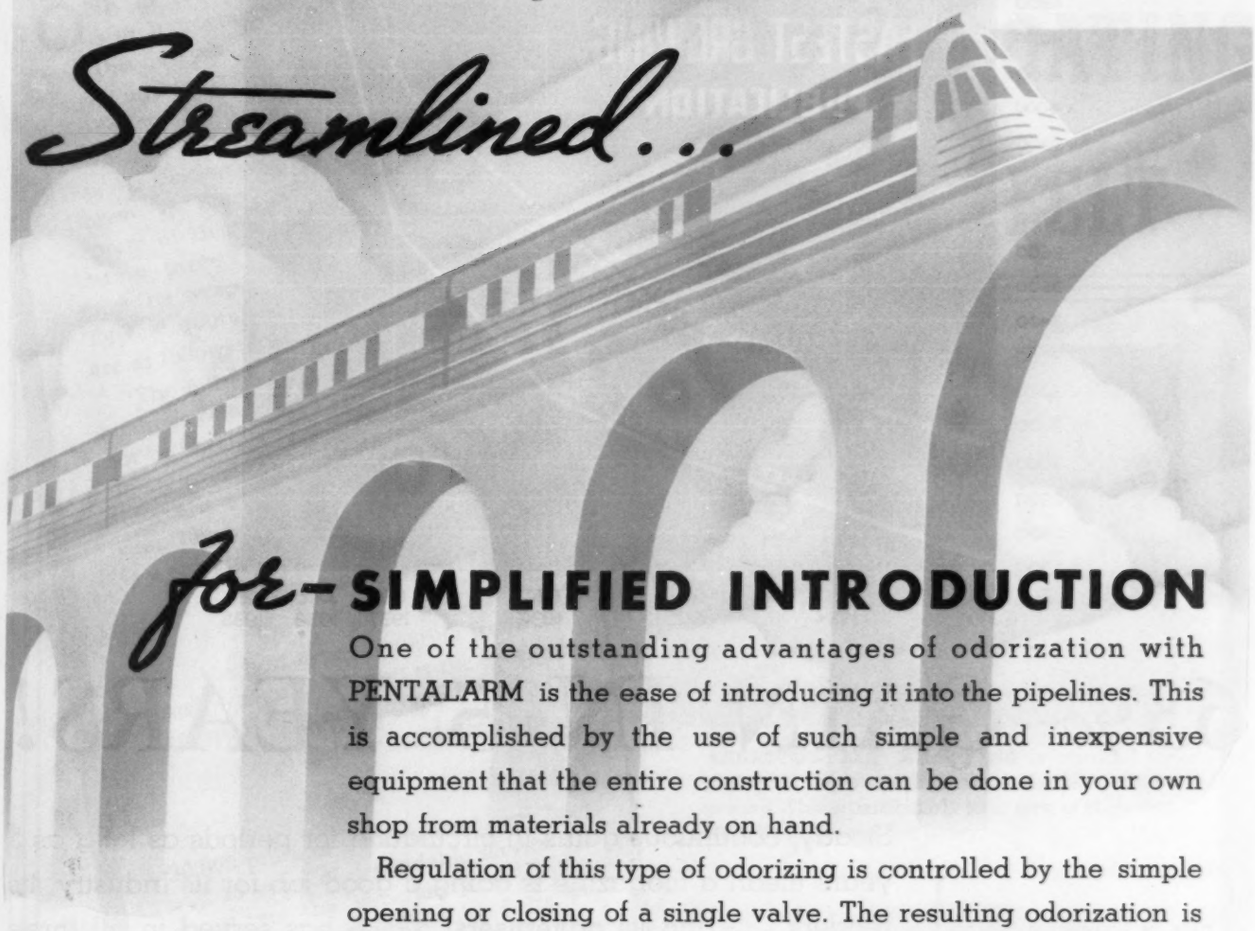
PENTALARM

THE WARNING ODOR FOR FUEL GASES

Streamlined...



for—SIMPLIFIED INTRODUCTION

One of the outstanding advantages of odorization with PENTALARM is the ease of introducing it into the pipelines. This is accomplished by the use of such simple and inexpensive equipment that the entire construction can be done in your own shop from materials already on hand.

Regulation of this type of odorizing is controlled by the simple opening or closing of a single valve. The resulting odorization is always uniform, regardless of variations in the gas flow.

Why experiment with less efficient odorizing methods when PENTALARM is so easy, so effective and so inexpensive to use? Play safe, for the sake of your investment and your community.

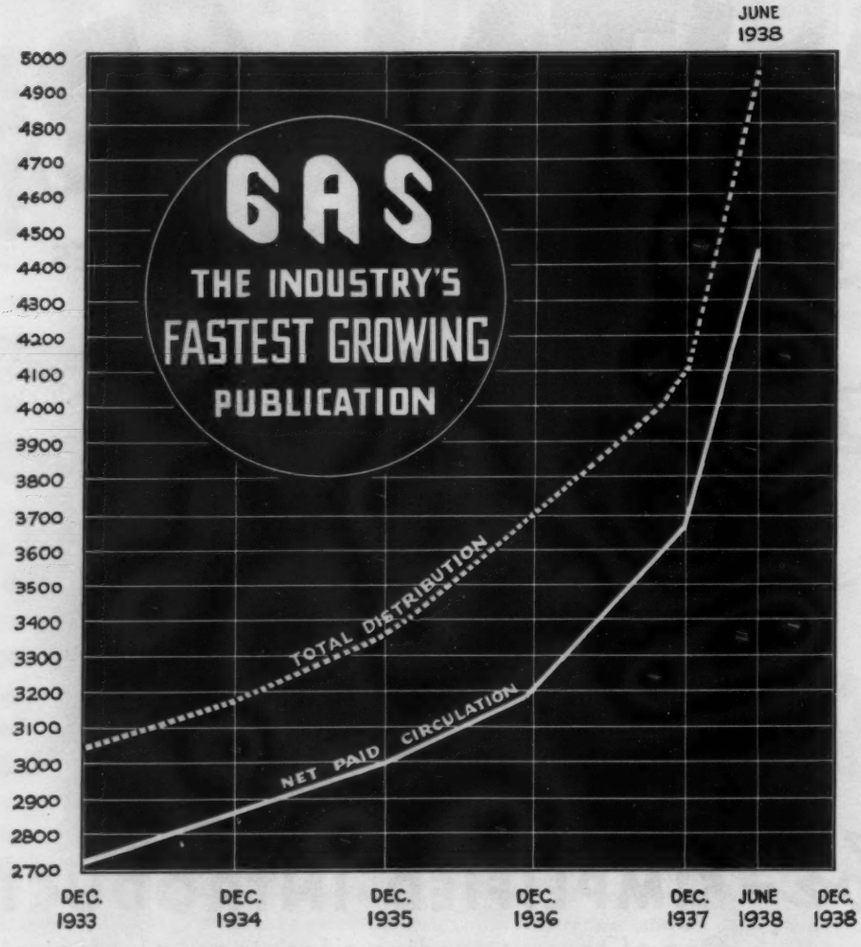
Two 55-gallon drums of PENTALARM will odorize 1 Billion cu. ft. of gas!

SHARPLES TRADE MARK SOLVENTS

Pentalarm Your Pipelines!

SHARPLES SOLVENTS

THE SHARPLES SOLVENTS CORP., 23rd and Westmoreland Streets, Philadelphia, Pennsylvania



63% GAIN IN 5 YEARS!

While the circulation of GAS has piled up a gain of 63% in the past 4½ years, advertising rates have remained the same for 7 years. Far-sighted advertisers have cashed in on this "bonus" in circulation. Those who recognize advertising values will take advantage of present rates now, before constantly increasing circulation makes higher rates necessary.

Steady, continuous gains in circulation for periods as long as 5 years mean a magazine is doing a good job for its Industry, its readers . . . and its **advertisers!** GAS has served in all three ways, as proved by its 63% gain in circulation in the last four and a half years . . . a record which far exceeds that of any other publication in the Gas Industry. Total circulation distribution of GAS for the first six months of 1938, averaged 4977 copies per issue.

ABC

GAS

ABP

810 S. Spring St. Los Angeles

Authorities Agree—

for lasting pipe protection

WRAP THE COATING WITH ASBESTOS FELT

ONE of the most outstanding research programs of the last decade was the five-year investigation of the causes and prevention of pipe-line corrosion conducted by the American Petroleum Institute and the American Gas Association in conjunction with the Bureau of Standards. The published reports of this survey prove that, for lasting protection, underground pipe must be wrapped with asbestos felts. Typical quotations from these reports are as follows:

"The full effect of the waterproofing qualities of a bituminous material cannot be obtained in underground service unless some means is employed to reinforce it against distortion and abrasion. The use of tough fabric wrappings is a recognition of this requirement."

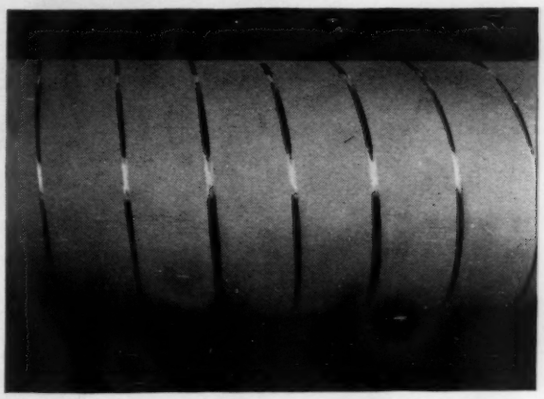
American Petroleum Institute

"... the best type of coating from the standpoint of protection is the asbestos (wrapped) reinforced coating."

American Gas Association

★

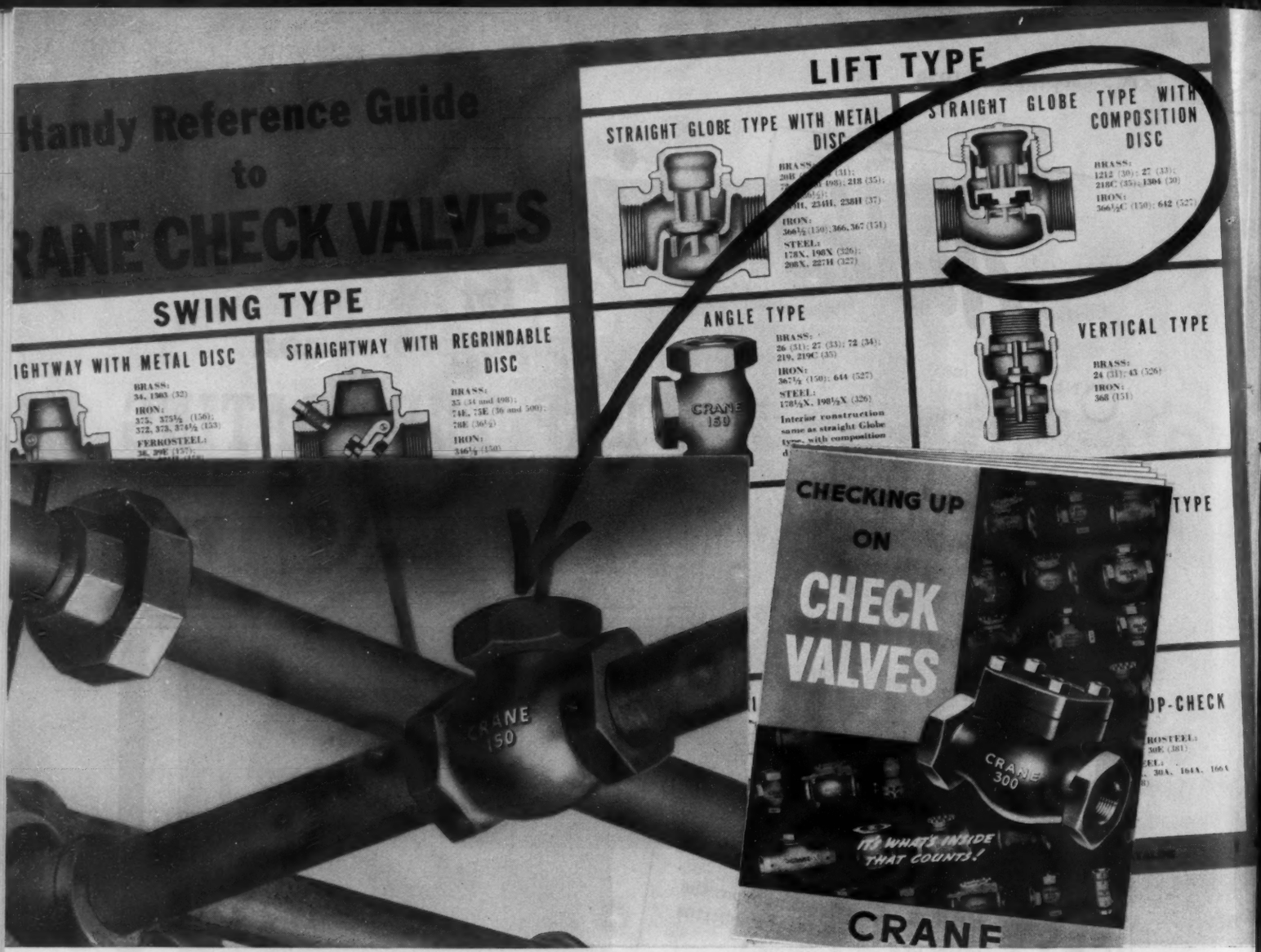
30,000 miles of underground pipe lines ... 25 years of dependable service ... attest to the superiority of Johns-Manville Asbestos Pipe-Line Felts. For complete information, write for Engineering Brochure D. S. 375. Johns-Manville, 22 E. 40th St., New York, N.Y.



ASBESTOS-FELT WRAPPING is essential for protecting pipe coatings from damage underground. This is particularly so in view of the softer enamels in general use today.

THE ELECTRIC FLAW DETECTOR provides a quick and accurate way to locate flaws in the coating either before or after the asbestos felt is applied. These flaws can then be easily repaired before the pipe is buried.

Johns-Manville ASBESTOS PIPE-LINE FELTS



WHERE TO USE THIS CRANE CHECK VALVE
...IN THE GAS INDUSTRY

Lift check valves with composition discs are especially suited for service where discs must be renewed easily and quickly. They may be used on steam, air, gas and other vapor lines—provided that flow is not subject to severe pulsations. But that's about as far as general working principles can be applied in check valve selection—be it composition or metal disc lift check, cushioned disc, swing type—or any of their many variations.

Check valves can't be picked by a formula. Crane makes more than 90 types—each designed for a specific service. What type is best suited to your needs and where to use composition or metal discs in lift or swing type valves can be decided only by thorough knowledge of check valves and experience in their use. Your Crane Representative is specially trained in the solution of back-flow control problems. He can offer the valve that is exactly matched to your requirements.

It's What's Inside That Counts!

It goes without saying that satisfactory performance of check valves depends on their quality as well as on selection of the proper type. Crane-Quality, backed by more than 80 years of manufacturing and valve engineering experience, is your assurance of superior goodness in Crane Check Valves all the way through—of proper design to perform efficiently, built right to give lasting service.

"Checking Up on Check Valves"

This new Crane booklet gives a lot of valuable information on the Crane line of check valves for every application. It contains the handy reference guide illustrated above. Write for your free copy today.

CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

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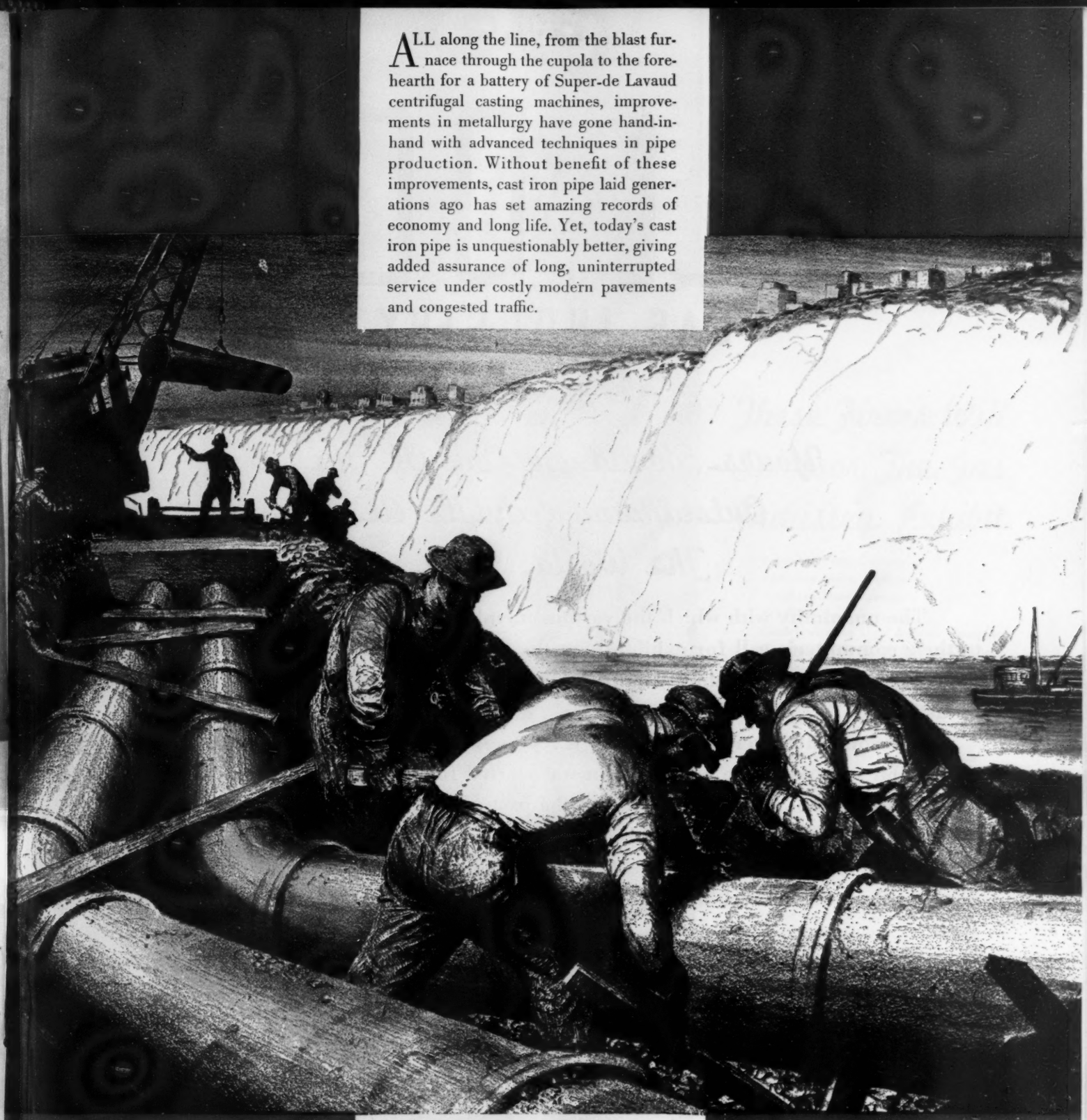
NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL IMPORTANT CITIES



ALL along the line, from the blast furnace through the cupola to the forehearth for a battery of Super-de Lavaud centrifugal casting machines, improvements in metallurgy have gone hand-in-hand with advanced techniques in pipe production. Without benefit of these improvements, cast iron pipe laid generations ago has set amazing records of economy and long life. Yet, today's cast iron pipe is unquestionably better, giving added assurance of long, uninterrupted service under costly modern pavements and congested traffic.

Lithographed on stone by James E. Allen for U. S. Pipe & Foundry Co.
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U.S. cast iron PIPE

SUPER-DE LAVAUD CENTRIFUGAL CAST IRON PIPE

U. S. Pit Cast Pipe — U. S. Mechanical Joint Pipe
U. S. Threaded Cast Iron Pipe
U. S. Ni-Resist Cast Iron Pipe
U. S. Flexible Joint Pipe — U. S. Cast Iron Culverts
Alloy and Gray Iron Castings
U. S. Cast Iron Roof Plates

Cast Iron Pipe, centrifugally or pit cast, for water works, gas, sewerage, drainage and industrial service.

U. S. PIPE & FOUNDRY CO.
BURLINGTON, NEW JERSEY
Foundries and Sales Offices throughout the U. S.

WELL DONE
GAS INDUSTRY

Yours Should Be One Of The Outstanding Exhibits At The World's Fair

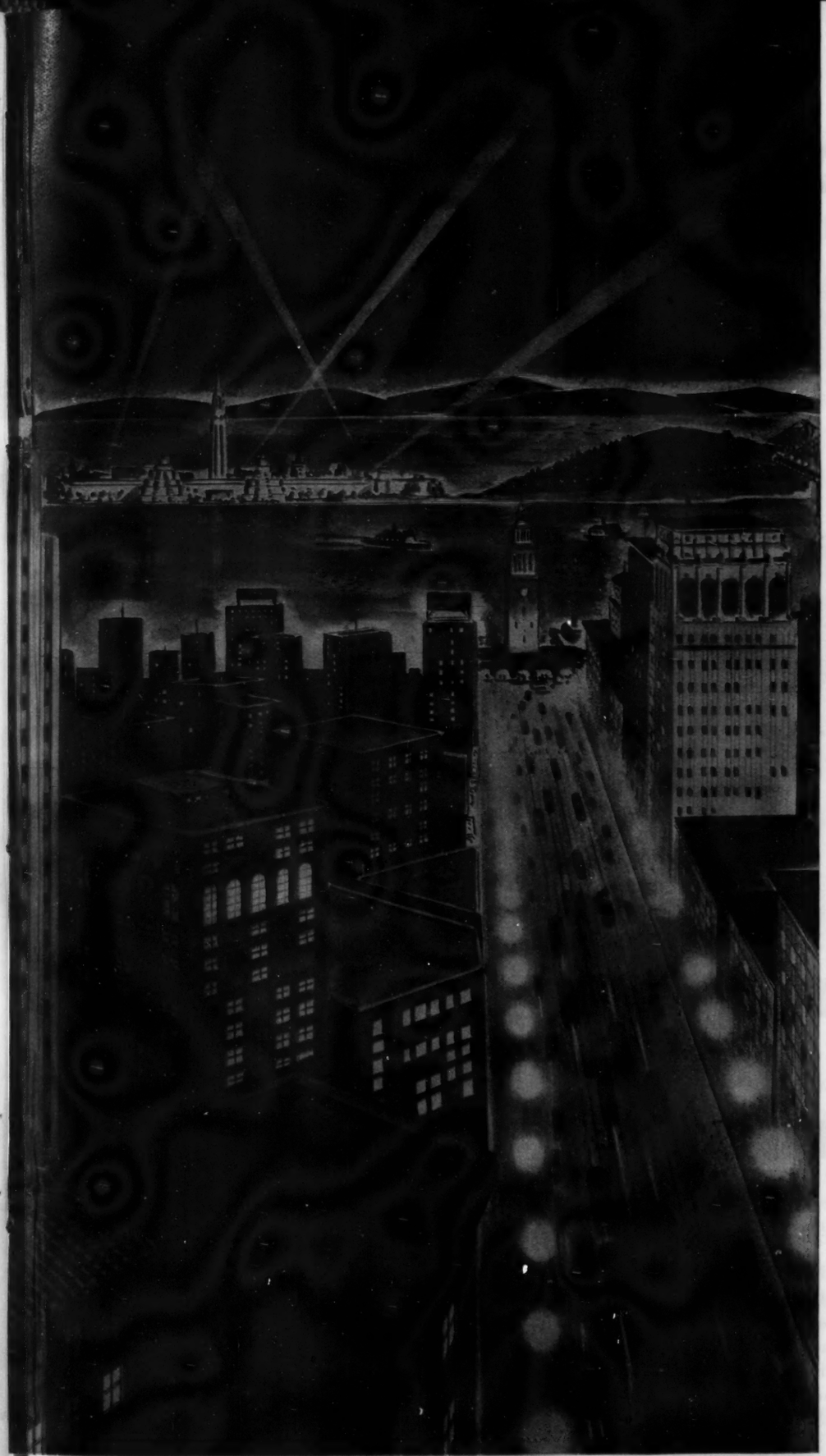
The unanimity with which the various members of the gas industry responded to their committee's call for exhibitors at the Golden Gate International Exposition is a gratifying demonstration of the farsighted cooperation which prevails in this industry.

The committee went to work only a few months ago, and even while plans for the exhibit were tentative a solicitation was started for funds. Despite the hardships which business has encountered during the past several years, the necessary fund of $140,000.00 was fully subscribed.

At the present time there is sufficient work done to promise a really exceptional display—beautiful, novel, interesting, completely in tune with the modernity of gas fuel.

When the exposition opens in 1939 and Treasure Island becomes a blaze of light and color and beauty—a veritable magnet attracting visitors from all the world, it is doubtful if any other industry exhibit will surpass this one.

Again we say—Congratulations Gas Industry! Your committee which planned the exhibit and you who are making it possible deserve much credit.



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PACIFIC GAS AND ELECTRIC COMPANY

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Pacific Gas Radiator Company
Pittsburgh Equitable Meter Company
Portland Gas and Coke Company
Republic Electric Power Corporation
Ruud Manufacturing Company
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Santa Maria Gas Company
Seattle Gas Company
Servel, Inc.
Sierra Pacific Power Company
Southern California Gas Company
Southern Calif. Gas Co. (San Joaquin)
Southern Counties Gas Company
Sprague Meter Company
S. R. Dresser Company
Ward Heater Company
Welsbach Company

NOTHING TAKES THE PLACE OF THE RUDDER

NOTHING TAKES THE PLACE OF CAST IRON PIPE

FROM the caravels of Columbus to the "Queen Mary," there has been no substitute for a ship's rudder. Since 1664, nothing has taken the place of cast iron pipe as an economical, long-lived material for underground mains.

If you want proved long life and low maintenance cost that result from effective resistance to corrosion—assured safety margins for impact, beam load and crushing stresses—and permanently tight joints—then you will agree that nothing takes the place of cast iron pipe. Some materials meet some of these requirements but only cast iron pipe meets them all.

CAST Q IRON

Look for the "Q-Check" registered trade mark.
Cast iron pipe is made in diameters from 1¼ to 84 inches.

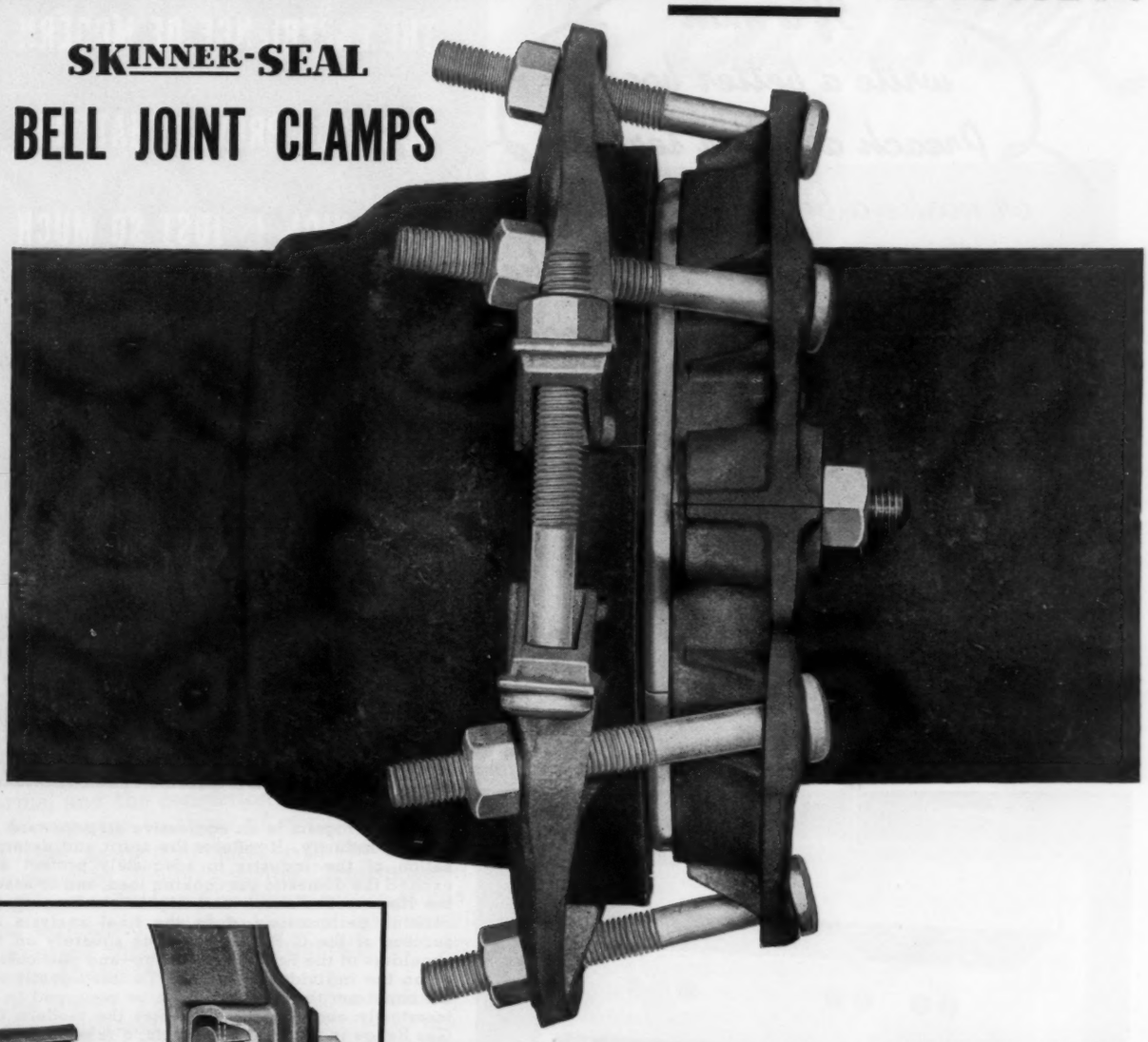
THE STANDARD MATERIAL FOR UNDERGROUND MAINS

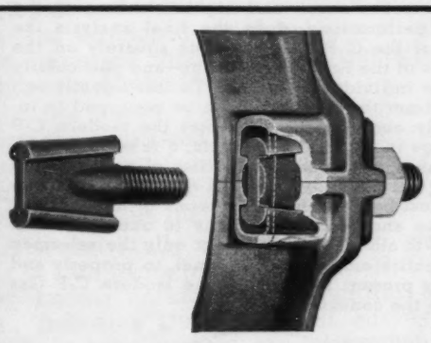
Recent installation of mechanical joint cast iron pipe for natural gas line.

THE CAST IRON PIPE RESEARCH ASSOCIATION, THOMAS F. WOLFE, RESEARCH ENGINEER, 1013 PEOPLES GAS BUILDING, CHICAGO, ILLINOIS

MONEL METAL BAND SEALS GASKET!

SKINNER-SEAL BELL JOINT CLAMPS





The new, patented Skinner Wedge Lock for holding the valves of the main ring together. It makes the most rigid ring ever used in a bell joint clamp.

The soft rubber gasket in a SKINNER BELL JOINT CLAMP is completely SEALED by monel metal band at bell face and hard vulcanized gasket tip at spigot. Pressure is sealed in; air, moisture and gasket-destroying soil conditions are sealed out! Complete adjustability for variations in pipe diameter reduces number of clamps you have to carry on hand. Speedy, one-man application cuts job costs. Send for new catalog just off the press.

M. B. SKINNER CO. *Est. 1898* SOUTH BEND, IND.

If a man write a better book, Preach a better sermon or make a better mouse trap than his neigbor, Though he builds his house in the woods The world will make a beaten path to his door . . .

★

THE EXPERIENCE OF MODERN BUSINESS PROVES THAT THIS OLD AXIOM IS JUST SO MUCH FICTION. TODAY, SUCCESSFUL SELLING DEPENDS ON INTELLIGENT SALES PRESENTATION.

Employee Education—the vital factor in (cp) Range Promotion!

The C-P Program is an aggressive step forward by the Gas Industry. It reflects the spirit and determination of the industry to adequately protect and expand the domestic gas cooking load, and to assure the Homemaker a new and higher standard of gas cooking performance. ¶ In the final analysis the success of the C-P Program rests squarely on the shoulders of the Sales Department—and particularly so on the individual salesman. To intelligently sell the consumer the salesman must be equipped to interestingly and properly interpret the modern C-P Gas Range in terms of basic facts. ¶ A sales presentation based on broad generalities of no particular meaning will not and cannot fill the bill—the Homemaker must be appealed to in terms of her interest. ¶ Cribben and Sexton Company is unusually well qualified to aid in educating, not only the salesmen but the entire employee personnel, to properly and forcefully present the case of the modern C-P Gas Range to the consumer.

UNIVERSAL (cp) THE PLUS RANGE

★ UNIVERSAL GAS RANGES

MANUFACTURED BY CRIBBEN & SEXTON CO., 700 NORTH SACRAMENTO BOULEVARD, CHICAGO, ILLINOIS

GAS
September, 1938

Guest Editorial

A United Front

By NORMAN R. McKEE
President, Pacific Coast Gas Association

THE militant slogans of the Pacific Coast Gas Association in recent years indicate a realization that there are opposing forces to be conquered not only theoretically, but actually, in a spirit of aggression. Maintenance of this attitude is largely dependent upon the confidence we display in our own arms, and the conviction that our weapons are equal or superior to those of our competitors.

The basic weapon of defense is the technological development of manufacturing, transmission and distribution facilities. The manufacture of gas from oil was developed by members of our association and improved methods of production still serve a large area of the Pacific Coast.

In the Pacific Coast Northwest a research program for additional by-products of oil-gas manufacture is being conducted with a foresight that will materially strengthen the position of gas as a competitive fuel in that area.

A recent study of the potential yield of natural gas in California made by Ralph E. Davis, a nationally known natural gas consultant of Pittsburgh, Pa., indicates that improved survey and drilling methods have enabled the oil companies to develop production from depths as great at 14,000 feet, and have increased known reserves nearly two and one-half trillion feet over a previous estimate made in 1935. Assurance of an adequate supply of natural gas will do much to stabilize the industry.

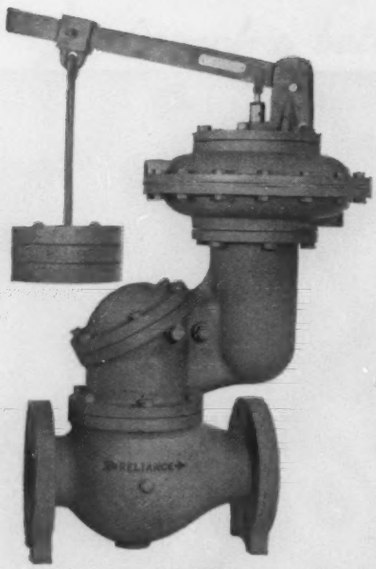
Conversely, the added production of natural gas has created an added production of oil and an equal increase in competition from this source. Conservation of natural resources makes it necessary that natural gas be consumed in the areas where it is available, and that oil, being transportable beyond this area, be used to supply other fuel requirements. The major oil companies, who also produce natural gas, have shown a favorable inclination to observe these limitations.

Sales programs have shown an aggressive tendency in recent years, and have recruited the gas appliance dealer as an aid in their promotion. The added consumer contacts created by the dealer group and their continued enthusiastic efforts will do much to accelerate the acceptance of improvements in gas burning equipment. Pomp and pageantry have been conspicuous by their absence from sales campaigns, but should not be overlooked as a possible aid.

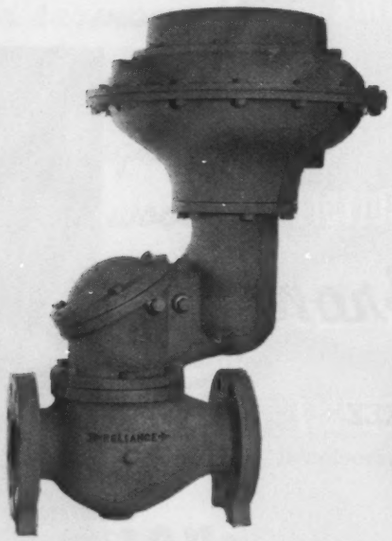
The Gas Industry has shown its interest in favorable public relations by instituting employee training courses, and has met the requirements of recent labor legislation in a constructive and sagacious manner. To a large extent the demands of the newly created labor oligarchy have been anticipated, and presentation of petitions for wage and hour reform has been minimized. Recognition of the rights of both employees and consumers has characterized the actions of management.

The Gas Industry will not cede its position in its chosen field, nor will it capitulate to opposing legions, however great. Organization, unity and independence, rather than numbers, are the essentials of an army; and, in coordinating these forces, the Pacific Coast Gas Association has played an important part.

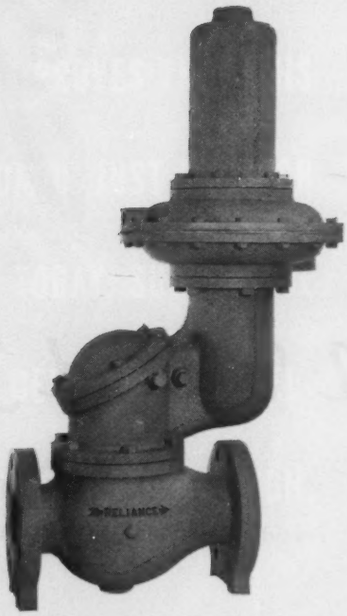
RELIANCE REGULATORS



High pressure, outside weight loaded CBV-200 offset connected reducing Regulator.

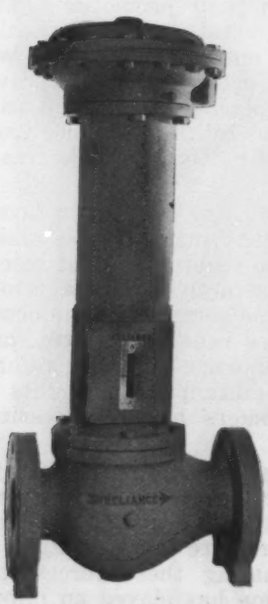


Low pressure, inside weight loaded CBV-300 offset connected reducing Regulator.



High pressure, spring loaded, CBV-201 offset connected reducing Regulator.

As Up-to-date as Today

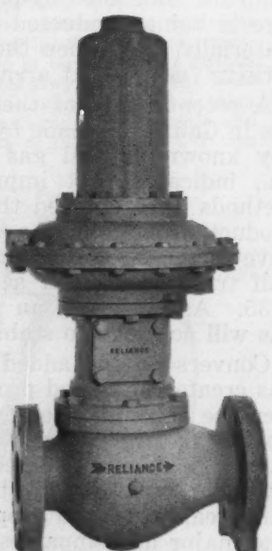


High pressure, under spring loaded, CBVA-400 direct connected reducing Regulator.

A new line of eighteen models of Combination Balanced Valve Regulators, in six sizes, all designed after years of intimate contacts in the field and careful studies of what modern conditions require. These Reliance Regulators are, by comparative tests, superior to all others in positiveness of action, accessibility of parts, compactness, and ratio of capacity to size. All are built on interchangeable standard bodies. Available with cast iron or cast steel bodies, in standard trim or stainless steel trim. Sizes 2" to 10". This new Reliance family provides the right Regulator for every distribution or industrial condition, and every inlet and outlet pressure.

Send for Bulletin No. 50

Reliance Regulator Corporation
1000 Meridian Avenue, Alhambra, California



High pressure, spring loaded CBV-101 direct connected reducing Regulator.

GAS

FOURTEENTH YEAR OF PUBLICATION

Thermally Thinking

By Stanley Jenks

Editor

A United Industry Such is the theme of the Pacific Coast Gas Association when it meets at Santa Barbara, Calif., September 14-16 for its 45th annual convention. The P.C.G.A. has much to its credit of which it is justifiably proud. In 1924, its member companies sold less than 100 billion cu. ft. of gas to approximately 1,150,000 customers. Today, and only 14 years later, it has more than doubled its annual sales, and has nearly twice as many customers, who are enjoying gas service at an average decreased cost of at least 25 per cent. The replacement of manufactured with natural gas is to some extent responsible for this splendid record, but it is fitting to remind ourselves that natural gas neither transmits, sells nor utilizes itself. Behind these vast stores of fuel in Mother Earth's bin, there are men with vision to plan, engineers with skill to translate these plans into realities, sales executives to promote, and utilization experts to operate. These are the men who will soon be assembling at Santa Barbara.

One of the greatest lessons anybody who would progress in the gas industry must learn, is that no branch of it is sufficient unto itself. With "CP" gas ranges so very much to the front these days, the complete details of the progress of a gas range from the manufacturer's plant to the customer's kitchen will illustrate the point simply. After the manufacturer has combined his research, experience and producing ability to make the gas range, it is shipped to the gas company's storeroom. But first, the sales department has or should have consulted the operating department to find out if the range's specifications and quality are adequate for the gas service itself. Then the sales department requisitions the range. The purchasing department orders it. The stores department receives it and checks its condition. The credit department approves its sale. The operating department either installs or supervises its installation. The accounting department collects the payments. The operating department maintains the gas range in first class operating condition. And all this departmental co-ordination is contingent on the production and distribution departments keeping an adequate supply of gas at proper pressures available on the customer's premises.

Therefore, to harness gas for cooking in that customer's home by selling her a gas range, practically every department of the gas company has had a part in the transaction. In the smaller companies there are fewer individuals concerned, but in principle, there is no exception.

The gas industry calls for a unified local operation, and because the industry has so many common problems to solve and experiences to share, a unified industry as typified by the P.C.G.A. is most essential.

George H. Smith and his convention committee have worked hard to make the Santa Barbara convention a real success. Judging by the advance technical papers, many of which we publish in this issue, the program is excellent. We are promised the usual high standard of entertainment and nothing, as I see it, has been left undone to make every delegate and the ladies welcome to what will undoubtedly be a most instructive and enjoyable convention.

An After Thought On the "CP" Range Our August issue, in which we tried to explain the sales possibilities and opportunities presented by the newly available "CP" range, has brought us many congratulatory letters from readers. It is human to like a pat on the back, but we get a greater satisfaction from the enthusiasm that these letters reflect.

And why shouldn't the entire industry enthuse over "CP"? Here is an appliance that raises our base load to a standard of excellence that no other competitive fuel can begin to touch.

I have heard some critics say that the retail price of the "CP" gas range might be a stumbling block. Were it just another gas range with a few gadgets hung on it, I might concede that their contentions have merit.

But, let's consider the "CP" range from this viewpoint. It definitely offers the user 18 ways of saving time and money. Six of these savings lie in the food itself, which is by far the greatest item of expense in the average family cooking budget. Through these savings, it can be proved that the

"CP" range more than pays for itself. For the life of me, I cannot see how any salesman worth his salt can possibly stumble with a better gas range which is not an additional expense to the user, but on the contrary starts to save money for the user the minute she has it installed in her kitchen. Once we realize that the "CP" range more than pays for itself, higher price complexes should disappear overnight.

Getting the Facts

When I was attending the Indiana Gas Association Convention, my former colleague, Gene Longgood, division manager of the Northern Indiana Public Service Company, Hammond, showed me the results of a market survey the boys had made in Crown Point, Ind.

Crown Point is the county seat of Lake County and has a population of around 4,000. It has enjoyed electric service far longer than gas service, as the latter has only run in there within the last 10 years. A refrigeration survey was made of 725 homes, and believe it or not, it was found that only 372 of these homes had any form of automatic refrigeration. There were 158 old-fashioned ice boxes, and 200 homes had no form of refrigeration whatsoever.

Now let's take a look at the electric automatic refrigerators, as the Public Service Co. boys found them. This is what they found:

Ten years and over	15	4.5%
Nine years	4	1.2%
Eight years	12	3.6%
Seven years	12	3.6%
Six years	12	3.6%
Five years	30	9.0%
Four years	21	6.3%
Three years	40	12.0%
Two years and less	186	56.2%

The above represent 23 different makes. There are 40 gas refrigerators in Crown Point also. The figures speak for themselves, and emphasize the great market there is now available for the replacement of obsolete electrically driven models with modern gas refrigerators.

Gas or Electricity

The more I study the conclusions in A. M. Beebee's paper given before the Production and Chemical Conference in June in New York (which paper I consider one of the most significant studies of the present era), the more I find myself reverting to Herman Russell's paper of last year on combination utility economics, presented when he was president of the A.G.A., as all gas men will vividly recall. The authors are colleagues at Rochester, N. Y., and both papers are really chapters supplementing each other in the same story of the economics of combination utility operation.

It will be recalled that Mr. Russell's objective primarily as a combination utility executive was to determine which was better for the customer and secondly, which services or combination of services were more profitable for the company. Cost studies from experience in the field, according to Mr. Russell proved conclusively for combination management, and—let's put it bluntly—that where gas service is available, it should be used for heating, cooking and water heating, if the better interests of both customer and company are to be advanced.

"Where the Rochester Gas and Electric Co. can readily deliver both gas and electric service in new territory," said Mr. Russell, "it should not consider straight electric service for the reason that such service, to be profitable, must be considerably more expensive to the customer and would require several times as much outlay of new capital by the company. If electric rates for cooking and water heating were to be made competitive with present gas rates so as to bring the cost of complete electric service down comparable with the present cost of combined service, the return from all electric service would be more than wiped out."

More specifically, Mr. Beebee points out electric cooking and water heating service to the customer is only profitable to the company at twice the cost of equivalent gas service. In Rochester, according to Mr. Beebee, a capital investment of $285.00 is needed for an electric range and every electric range added to the system means an annual cost of $43.00 to produce an annual revenue of $39.00.

It requires no Einstein to figure out that you can't make any money that way, and that such a service is equally disadvantageous to the customer. I feel that the more we can drag the true facts out into the light, the better it is going to be for all... including the electric industry.

Concerning Liquefied Petroleum Gas

I agree that the term "bottled" gas was a misnomer and was quite rightly thrown in the ash can. But, I have little liking for its present name "liquefied petroleum" gas. It may be technically correct, but as a generic term for this gas, I think it has little if any merit, when talking to a potential layman customer. Some duck the issue by talking about "butane" and "propane," and even then, there is a big query in the customer's mind. Many of the liquefied petroleum gas distributors have their own trade names for the gas. They have trade names too in the gasoline business, but they still have "gasoline" to identify and define their fuel itself.

It has been suggested that the liquefied petroleum gas boys take a leaf from the copybook of their older brethren in the gas business. The public talks about "city" gas when they have piped gas service in mind, with no further concern as to whether the gas is coal, water or oil manufactured gas or natural gas in its many variations. To the public it is all "city" gas.

Why not, it is suggested, adopt the term "rural" or "country" gas for liquefied petroleum gas? The public which readily recognizes "city" gas would soon equally recognize "rural" gas. Popularizing such a term, I believe, would be a big step forward in defining the purpose and place of this gas as it exists in the picture today.

Anyway, it's an idea for the Liquefied Petroleum Gas Association to play with, and from their discussions a better generic term might be found to cover the sales promotional angle, which prompted the above suggestion.

The Pacific Coast Gas Association's

45th Annual Convention

WITH reservations continuing to pour in by the hundreds, all accommodations at the Biltmore Hotel, convention headquarters, already taken, and accommodations at the adjacent Hotel Mar Monte practically exhausted, Clyde H. Potter, reservation committee chairman, predicts, as *G A S* goes to press, a record attendance at Pacific Coast Gas Association's 45th annual convention at Santa Barbara, September 14, 15, and 16. Arrangements have been made, he states, for additional quarters at the Montecito Inn, adjoining the Biltmore properties, and at the El Encanto, Barbara, Carillo and Faulding hotels, all situated in the City of Santa Barbara.

Among early reservations are the following from prominent gas industry representatives over the country: H. N. Ramsey, president, Welsbach Co., Gloucester, N. J.; E. H. Poe, secretary, Natural Gas Department, A. G. A., Dallas, Texas; N. C. McGowen, president, American Gas Association; R. E. Coles, manager, Cia Panamena de Fuerza y Luza, Panama, Canal Zone; R. M. Conner, director, A. G. A. Testing Laboratory, Cleveland, Ohio; Mr. and Mrs. A. B. Allyne, California State Railroad Commission, San Francisco; Col. W. F. Rockwell, president, and Capt. A. E. Higgins, vice president, Pittsburgh Equitable Meter Co., Pa.; Robt. A. Hornby, vice president, Pacific Lighting Corp., San Francisco; W. P. Hutchinson, president, Sprague Meter Co., Bridgeport, Conn.; Louis Ruthenberg, president, Servel, Inc., Evansville, Ill.; H. A. Strong, vice president, Servel, Inc., San Francisco.

George W. Smith, general convention chairman, manager of Southern Counties Gas Company's Santa Barbara District, is doing everything possible to make the convention a success. In addition to arranging entertainment for delegates during the three days of the convention, he is preparing special sightseeing trips and card parties for delegates' wives. Special plans for the entertainment of the delegates have been arranged for each evening of the convention. The Annual Men's Golf Tournament will be played Saturday morning at La Cumbre Golf and Country Club beginning at 9:00 A.M.

Mrs. Norman R. McKee will be the convention hostess. Assisting General Chairman Smith are the following committee chairmen: A. R. Combs, properties; George H. Finley, golf;

GAS CAMERA *Glances Backward*

The Pacific Coast Gas Association returns this month to Santa Barbara, Calif. for its 45th Annual Convention. Upon looking through the pictures on this page, delegates to this 1938 conclave may recognize themselves and many of their gas industry friends in this photo of the Association's 31st Annual Convention at the Hotel Arlington, Santa Barbara, Calif., Sept., 1924.

W. W. Fitkin, entertainment; J. C. Gilbert, attendance and reception; R. W. Gregory, transportation; E. B. Hanmer, banquet; P. E. Kling, registration; Homer Laughlin, Jr., convention newspaper; Otto Mauthe, publicity, and C. H. Potter, hotel accommodations.

The tentative program for the convention follows:

GENERAL SESSION

SEPT. 14—10:00 A. M.—BALLROOM

The Romance of Santa Barbara—Hon. Patrick J. Maher, Mayor of Santa Barbara.

A United Industry—Norman R. McKee, president, Pacific Coast Gas Association.

Election of Officers.

Address—N. C. McGowen, president, American Gas Association.

In Memoriam.

Luncheon will be served in the Biltmore Dining Room. The menu has been selected by the Convention Committee to expedite service. Guests at the Biltmore and the Mar Monte will have received luncheon tickets. Those at other hotels may purchase tickets from the Biltmore cashier for $1.50.

PARALLEL SESSIONS

ACCOUNTING SECTION

SEPT. 14—2:00 P. M.—LOWER LOUNGE

H. E. Davidson, General Chairman
Southern California Gas Company

Address of Chairman.

Discussion:

1. Use of Collection Agencies: (a) Appliance Stores, (b) Furniture Stores, (c) Hardware Stores, (d) Plumbing Shops, (e) Banks, (f) Drug Stores—Led by V. C. Pack, Southern California Gas Co.
2. Advisability of Collecting Deposits from Domestic Customers—Led by W. J. McCoy, Southern Counties Gas Co.
3. Desirability of Securing Customers' Signatures on Orders—Led by H. T. Terry, Pacific Gas and Electric Co.
4. Use of Open or Closed Territory for (a) Meter Reading, (b) Collecting—Led by L. E. Green, Southern California Gas Co.

SALES and ADVERTISING SECTION

SEPT. 14—2:00 P. M.—BALLROOM

Norbert O. Fratt, General Chairman
Seattle Gas Company

Address of Chairman.

The Certified Range Program—A. F. Rice, manager market development, Southern California Gas Co.

What the Dealer Can Do for Us—J. J. Winn, Jr., commercial manager, Portland Gas and Coke Co.

Selling Heat in Hot Climates—Louis Wollenberger, Coast Counties Gas & Electric Co.

This Publicity Business—Otto Mauthe, Southern California Gas Co.

Neighborhood Newspapers—A. C. Joy, advertising manager, Pacific Gas and Electric Co.

TECHNICAL SECTION

A. B. Allyne, General Chairman
California Railroad Commission

DISTRIBUTION COMMITTEE

SEPT. 14—2:00 P. M.—ROOM 44

H. G. Laub, Chairman
Southern California Gas Company

2:00—3:00 p. m.

Report of the Sub-Committee on Leakage—W. F. Pape, Pacific Gas and Electric Co., Chairman.

(a) Measurement of Leakage from High Pressure Distribution Systems*—D. B. Larson, Portland Gas & Coke Co.

(b) Improvements in Methods for Testing Old Mains and Services at Elevated Pressures—R. C. Merrick and R. W. Gregory, So. Counties Gas Co.

3:00—3:45 p. m.

Report of the Sub-Committee on Servicemen's Training—B. E. Embry, Southern California Gas Co., Chairman.

(a) Field Equipment for Servicemen—H. A. Johnstone, Southern California Gas Co.

(b) Safety Education—E. E. Ellis, Southern California Gas Co.

3:45—4:15 p. m.

Report of the Sub-Committee on Construction and Maintenance—C. P. de Jonge, San Diego Consolidated Gas and Electric Co., Chairman.

(a) Tools and Materials for Street Service Trucks—L. L. Biggs, Southern California Gas Co.

4:15—5:00 p. m.

Report of the Sub-Committee on Transportation and Stores—C. D. Weiss, San Diego Consolidated Gas and Electric Co., Chairman.

(a) Modern Developments in Automotive Equipment, Portable Compressors and Warehousing for Gas Distribution Work—H. G. Lawrence, Southern Counties Gas Co.

(b) Stores Department Methods Affecting Gas Distribution Material Issues—W. deWaard, San Diego Consolidated Gas and Electric Co.

(c) Advancements in Transportation and Construction Equipment for Distribution Work—W. E. Frazer, San Diego Consolidated Gas and Electric Co.

TRANSMISSION COMMITTEE

SEPT. 14—2:00 P. M.—ROOM 47

F. E. Wilson, Chairman
Pacific Gas and Electric Company

2:00—3:30 p. m.

Report of the Sub-Committee on Pipe Protection—C. F. Briscoe, Southern California Gas Co., Chairman.

(a) Effect of Soil on Asphalts—D. R. Hiskey, Southern California Gas Co.

(b) The Effect of Freezing Ground Conditions on Pipe Line Coatings—R. G. Roberts, Barrett Co.

3:30—5:00 p. m.

Report of the Sub-Committee on Large Volume Measurement — G. B. Reece, Southern Counties Gas Co., Chairman.

(a) Pulsation—Its Detection and Elimination*—T. K. M. Smith and R. E. Morter, Industrial Fuel Supply Co.

(b) The Effect of Distributed Deliveries on the Capacity of a Transmission Line*—E. H. Fisher, Coast Industrial Gas Co.

PRODUCTION COMMITTEE

SEPT. 14—2:00 P. M.—ROOM 45

J. E. Kelley, Chairman
Pacific Gas and Electric Company

2:00—2:30 p. m.

Maintenance of Gas Service in San Diego During a Natural Gas Outage—D. H. Perkins, San Diego Consolidated Gas and Electric Co.

2:30—5:00 p. m.

Report of the Sub-Committee on Butane-Air Standby Plants — A. R. Bailey, Coast Counties Gas and Electric Co., Chairman.

(a) Butane-Air Standby Plants in Southern California — L. R. Pickup, Southern California Gas Co.

(b) Butane-Air Standby Plant of the Coast Counties Gas and Electric Co. at Santa Cruz—A. R. Bailey, Coast Counties Gas and Eectric Co.

On Thursday morning, Sept. 15, breakfast tables in the Biltmore Dining Room will bear signs inviting those of like interests to sit together. There will be no speeches. The breakfast menu has been selected by the Convention Committee. Guests at the Biltmore and Mar Monte will have received breakfast tickets; others may purchase tickets from the Biltmore cashier for $1.50.

GENERAL SESSION

SEPT. 14—8:00 P. M.—BALLROOM

Arrangements have been made to show the motion picture, "White Banners." The remainder of the evening will be devoted to dancing.

GENERAL SESSION

SEPT. 15—9:30 A. M.—BALLROOM

Experience with Installment Financing—J. W. Vanier, office engineer, Southern California Gas Co.

The Manufacturer's Place in a United Industry—H. N. Ramsey, president, Welsbach Co.

Gas at the Golden Gate International Exposition—R. E. Fisher, vice-president, Pacific Gas and Electric Co.

Results from National Advertising—James F. Pollard, president, Seattle Gas Co.

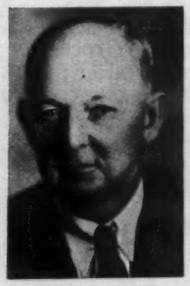
*Published in this issue of *GAS*.

H. E. DAVIDSON
Chairman, Accounting Section

A. J. NOIA
Chairman, Educational Committee

A. B. ALLYNE
Chairman, Technical Section

N. O. FRATT
Chairman, Sales and Advertising Section



C. R. GRAHAM
Chairman, Manufacturers' Section

A. C. JOY
Chairman, Cooperative advertising

Labor Problems — Paul Shoup, president, Southern Californians, Inc.

Luncheon arrangements will be the same as on Wednesday, Sept. 14.

PARALLEL SESSIONS

SALES and ADVERTISING SECTION

Norbert O. Fratt, General Chairman
Seattle Gas Company

DOMESTIC SALES and HOME SERVICE COMMITTEES

SEPT. 15—2:00 P. M.—BALLROOM

H. W. Edmund, Chairman Domestic Sales
Coast Counties Gas and Electric Company
Ruth D. Kruger, Chairman Home Service
Central Arizona Light and Power Company

Showmanship in Appliance Selling — Norbert O. Fratt, domestic sales manager, Seattle Gas Co.

Home Service Racing Bureau—A skit written and enacted by members of the home service department, Southern California Gas Co.

Side Lights of Home Service—Beatrice Strege, Seattle Gas Co.

The Appliance Counselor Program of Pacific Gas and Electric Co. — B. W. Reynolds, Pacific Gas and Electric Co.

Dealer's Paradise—W. H. Grove, general sales manager, Central Arizona Light and Power Co.

The Best Refrigerator to Buy—Jane Tiffany Wagner, home service division, Servel, Inc.

EDUCATIONAL COMMITTEE

SEPT. 15—2:00 P. M.—SHIP ROOM

A. J. Noia, Chairman
Pacific Gas and Electric Company

Address of Chairman.

Employee Training Courses and Training Methods—Harrison Musgrave, assistant personnel manager, Southern Counties Gas Co.

Factors Affecting Public Relations — George Mackenzie, assistant treasurer, Portland Gas and Coke Co.

General Employee Activities—Charles Grunsky, chief engineer, Coast Counties Gas and Electric Co.

TECHNICAL SECTION

A. B. Allyne, General Chairman
California Railroad Commission

DISTRIBUTION COMMITTEE

SEPT. 15—2:00 P. M.—ROOM 44

H. G. Laub, Chairman
Southern California Gas Company

2:00—3:45 p. m.

Report of the Sub-Committee on Special Problems—Frank Wills, Pacific Gas and Electric Co., Chairman.

(a) Gas Calorimetry*—W. A. McGlashen, Southern California Gas Co.

(b) Elimination of Dust—C. W. Capwell, San Diego Consolidated Gas and Electric Co.

(c) Economics of Oil Fogging*—J. L. Oberseider and R. G. Holman, Southern California Gas Co.

(d) Observing the Movement of Gas Main Dust—L. O. Emmerichs and D. J. Smith, Southern California Gas Co.

3:45—5:00 p. m.

Report of the Sub-Committee on Measurement and Regulation—H. A. Faull, Southern Counties Gas Co., Chairman.

(a) Testing of Gas Meters at Low Rates of Flow—C. W. Capwell, San Diego Consolidated Gas and Electric Co.

(b) Equipment for Grinding Meter Valves—Otto Goldkamp, San Diego Consolidated Gas and Electric Co.

TRANSMISSION COMMITTEE

SEPT. 15—2:00 P. M.—ROOM 47

F. E. Wilson, Chairman
Pacific Gas and Electric Company

2:00—3:30 p. m.

Report of the Sub-Committee on Compressor Plants—A. B. Newby, Southern California Gas Co., Chairman.

(a) Centrifugal Water Pumping System for Transmission Line Gas Cooling* —H. J. Smith, Pacific Gas and Elec. Co.

(b) Cooling Gas Engines with Water-Cooled Pistons—Leal Davis, Pacific Gas and Electric Co.

3:30—5:00 p. m.

Report of the Sub-Committee on Pipe Lines—R. T. Peterson, Pacific Gas and Electric Co., Chairman.

*Published in this issue of *GAS*.

(a) The Mechanics of Storage in Natural Gas Transmission Lines*—P. E. Beckman, Pacific Gas and Electric Co.

(b) Effect of Calcium Chloride Dehydration on Natural Gas Transmission* —J. V. Cowan, El Paso Natural Gas Co.

UTILIZATION COMMITTEE

SEPT. 15—2:00 P. M.—ROOM 45

R. I. Snyder, Chairman
Southern California Gas Company

2:00—3:15 p. m.

Report of the Sub-Committee on Appliance Testing—J. P. Dresen, Public Service Co. of Colorado, Chairman.

(a) Effect of High Altitude on Gas Furnace Operation*—J. C. Mueller and L. C. Morris, Payne Furnace and Supply.

(b) Experience with Fixed Orifices in Domestic Appliances* — H. W. Geyer, Southern Counties Gas Co.

(c) Preadjustment and Shop Inspection of Gas Appliances Before Delivery to Customer—J. P. Dresen, Public Service Co. of Colorado.

(d) Gas Company Appliance Specifications—F. O. Suffron, supervisor, A. G. A. Testing Laboratory, Los Angeles.

3:15—3:45 p. m.

Report of the Sub-Committee on Inspection of New Appliances—C. A. Renz, Southern California Gas Co., Chairman.

(a) Warehouse Inspection of Refrigerators—E. H. Mohr and R. I. Snyder, Southern California Gas Co.

3:45—4:15 p. m.

Report of the Sub-Committee on Air Conditioning — Glen Miller, Southern Counties Gas Co., Chairman.

4:15—5:30 p. m.

Report of the Sub-Committee on Standardization of Appliance Installations—C. E. White, San Diego Consolidated Gas and Electric Co., Chairman.

(a) Ordinances Regulating Housepiping and Gas Appliance Installations—H. N. Johnson, So. California Gas Co.

GENERAL SESSION

SEPT. 15—8:00 P. M.—BALLROOM

"Pots and Plans," a talking motion picture on kitchen planning prepared by the London (England) Gas Light and Coke Co. to show to customers.

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Pacific Coast Gas Association

Technical Section

A. B. ALLYNE, General Chairman

The reports and papers published on the following pages will, among others, be presented for discussion at the Annual Convention of the Pacific Coast Gas Association to be held at the Santa Barbara Biltmore, Santa Barbara, California, September 14, 15 and 16, 1938.

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A Convenient and Accurate Method Of Making Calorimetric Determinations*

By W. A. McGLASHEN

Southern California Gas Company

THE primary purpose of this paper is to set forth a method of determining the accurate heating value of a gas by use of the water-flow calorimeter and to introduce mechanical equipment that eliminates inaccuracies now recognized in the usual procedure.

The usual procedure, herein referred to as the "humidity correction method," is the method which requires the application of a humidity correction to the observed heating value to arrive at the total heating value of a gas. This method is given in Technologic Paper No. 36 of the Bureau of Standards, together with humidity corrections for observed heating values of 600 and 1000 B.t.u. gases.

It is recognized that the use of the "humidity correction method" results in inaccuracies because of the fact that the humidity and other correction factors used in this method are necessarily based upon a very definite operating control for the particular gas under test. This operating control is, at best, very difficult and, in most instances, impossible to obtain when testing the variable heating value gases of today.

The continuously increasing demand for more accurate measurement of the heating value of gases has resulted in the widespread use of the Thomas Recording Calorimeter, which when calibrated throughout its entire operating range, against a known standard of determining heating values, or against gases of known heating values, produces a continuous record of the average heating value of the gas being tested to an accuracy not obtainable by any other method. However, since it is essential that the recording calorimeter be calibrated through its entire operating range,† a basic method of calibration must be used. A true basic method for determining heating values of gases is defined as that method which requires no calibration against other methods. It is believed that the instrument and method herein described provide an improved practical basic method. Since its adoption, the calibration of Thomas Recording Calorimeters is now done with bottles filled with the available gas, the heating value determined in a central calorimeter station, and these samples taken to the recording calorimeters. By utilizing this method, a great saving in time has resulted besides providing a calibration sample in the operating range of the recording calorimeter. It is no longer necessary to be sure of the purity of hydrogen and make the mechanical changes necessary as outlined in Standards Research Paper No. 519.

The determination of gas heating values, using a water flow calorimeter, has been considered by many as a method of sufficient accuracy for the direct calibration of recording calorimeters as well as a basic method to be used to test a reference or calibrating gas sample. Thus, in effect, the water flow calorimeter method has been considered a true basic method although the auxiliary equipment, procedure, and calculations, have not been modified to include an authoritative accurate method for determining the heating values of variable heating value gases.

When the writer was placed in charge of Calorimetric work, it became necessary to find the reason for occasional serious discrepancies between the results obtained by five Thomas Recording Calorimeters and the two water flow calorimeters with which they had been calibrated.

A comparison between these results, showed that the recording calorimeters gave results in close agreement on the same gas samples, whereas corresponding flow calorimeter tests made in the usual manner on the same gas samples, did not always agree with the recording calorimeters, or even with each other.

In the investigation which followed to determine the reason for the above mentioned discrepancies, it became apparent that there was a very definite need for more information regarding the corrections to be used in calculating the total from the observed heating values obtained with a water flow calorimeter by the "humidity correction method." Therefore, the published results of experiments by several different investigators were used to derive the following empirical equation:‡

$$Y = \frac{0.00092\ H^{0.0159\ T}}{51.65\ H^{0.071598}} (X_o - X) \quad . \quad . \quad . \quad (7)$$

in which

$$X_o = 51.65\ H^{0.071598} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The general empirical equation (7) is adequate for determining the humidity correction Y for any observed heating value H, (except that of air-gas mixtures), when the relative humidity of the combustion air is X at the temperature T, and when the water flow calorimeter is operated under the conditions specified in the "humidity correction method." When testing gas-air mixtures, this equation may be used, with slight error, by substituting 90 for X_o.

Fig. 1 is a chart giving the most convenient method for the solution of general empirical equation (7). This chart has been slightly rearranged from that shown on page 142, *Proceedings*, Pacific Coast Gas Association, 1936, for purposes of clarity and ease of operation. The values for X_o given in tabular form have been extended to include 3200 B.t.u. gas, and an X_o value for all butane-propane gas-air mixtures. A further explanation of the use of X_o values in the "humidity and temperature control" method has been added. Also, there has been added a note under the sample solution which defines the conditions under which the alignment chart is used.

When a flow calorimeter is operated by the "humidity correction method," the observed heating value must be corrected, both for loss of heat to the surroundings, and also, for heat carried off in the flue gases, to arrive at the total heating value of the gas.

The corrections to the observed heating value which allow for the latent heat of that part of the water which is formed in combustion, and which is carried off as vapor in the flue gases, are known as humidity corrections. These corrections are affected by the volume and humidity of the combustion air, their magnitude depending upon the excess (or deficiency), of water carried out over that carried into the calorimeter combustion chamber. Therefore, equations or tables which give these corrections are necessarily based upon a very definite operating control, namely, equality between combustion air, inlet water, and flue gas temperatures, and exactly 40 per cent excess air for combustion for the particular gas under test.

It is generally agreed that the maintenance of 40 per cent excess air for combustion requires an accurate chemical analysis of the particular gas under test, followed by analyses of the flue gases, which in turn must be interpreted in connection with the analysis of the gas under test, until the proper damper setting at a particular gas rate has been determined.

From the above stated considerations, it is readily understood that an accurate determination of the total heating value of a gas by the "humidity correction method" requires time consuming adjustment of the instrument; a knowledge of the chemical analysis of the gas under test; also, a considerable supply of the gas sample. The difficulty of making these adjustments when testing gases of variable heating values is apparent.

The need for an instrument to eliminate the above mentioned difficulties, through a proper control of the temperature and humidity of the combustion air for water flow calorimeters, has been recognized and several attempts to construct such an instrument have been made, but due, probably to the fact that the information as to the requirements of such an instrument was limited, these instruments have not been entirely satisfactory in their application to the testing of natural, and other gases of higher heating values.

DESIGN OF INSTRUMENT

The purpose of this instrument is to enable the operator to have such control of the humidity and temperature of the combustion air for a water flow calorimeter as to eliminate the necessity for the application of corrections to the ob-

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*This paper supplements a paper submitted by Mr. McGlashen in 1936. See *Proceedings Pacific Coast Gas Association*, Vol. 27 (1936) p. 135.

† In industrial gas calorimetry, "entire operating range," is defined as the range between the actual minimum and maximum total heating value of the gas being tested by use of the recorder.

‡ For a complete derivation of this equation and humidity correction tables from its solution, see p. 135, *Proceedings* of the *Pacific Coast Gas Association*, Vol. 27, (1936).

served heating value. This will enable one to obtain correct total heating values, when the calorimeter is operated at other than 40 per cent excess air for combustion, (when combustion is complete). By so doing, the water flow calorimeter is converted into a fundamental instrument.

The special empirical equation (6) gives the relative humidity of the combustion air X_o at which a water flow calorimeter must be operated for the observed heating value H in order that the correction for humidity of the combustion air be zero, when combustion is complete, and the entering water, gas, combustion air, and flue gases are at approximately the same temperature. This equation may be used for any gas. However, its use when testing air-gas mixtures will result in slight error, since for this type of gas the relative humidity of the combustion air for zero correction is 90.

The values of X_o for the observed heating values of gases from 100 to 3,200 B.t.u. are given in tabular form on the chart, Fig. 1.

By the use of the above mentioned equation, together with due consideration to the conditions under which a water flow calorimeter must be operated for the accurate determination of total heating values, the following general considerations governing the design of an instrument for control of the temperature and humidity of flow calorimeter combustion air were written.

General Considerations Governing Design

Any device for the control of the temperature and humidity of the combustion air for water flow calorimeters should be so designed that the following requirements are met:

1. The design should be such that, by simple mechanical adjustment of the instrument, it may be made to increase the per cent relative humidity of the combustion air from a very low point (10 per cent), to near saturation (95 per cent), at the temperature of the calorimeter inlet water, when the calorimeter requires the maximum volume of air for combustion, and to increase the relative humidity of the combustion air from the same low point to only 70 per cent relative humidity at the temperature of the calorimeter inlet water, when the calorimeter requires the minimum volume of air for combustion, and at approximately two per cent relative humidity intervals between 70 and 90 per cent.

2. The instrument should be so designed that any mechanical adjustment necessary for humidity control of the combustion air will not result in a change within the instrument which would affect either the volume, or free flow of air to the calorimeter combustion chamber. That is, the volume of air delivered to the calorimeter must depend upon the natural draft of the calorimeter only.

3. The instrument must be equipped with a dependable psychrometer to determine the temperature and relative humidity of the air that is being delivered to the calorimeter, and so placed that it is protected against abuse, or damage.

4. The instrument should be attached to a burner housing through a short air duct, equipped with an easily manipulated air-tight joint.

5. The instrument should require few, if any, moving parts.

6. All metal used in construction should have a high corrosion resistance.

7. The dimensions of the instrument should be kept at a minimum to conserve bench space.

8. The cost of manufacture, operation, and maintenance, should be kept at a minimum, but not at the expense of accuracy.

Preliminary Experimental Work

An investigation by the writer to determine by comparison, the efficiency and practicability of the different types of instruments and methods that might be used for the control of the humidity and temperature of the combustion air for water flow calorimeters, resulted in the elimination of all of the proposed methods and instruments, with the exception of the water-spray method.

Since the results of the preliminary work indicated that a proper application of the water-spray method would satisfy the general considerations governing design of such an instrument, a crude working instrument was constructed and further tests were conducted by operating a flow calorimeter with this attachment.

The results obtained with this crude instrument, while not entirely satisfactory because of imperfections in construction and mechanics of operation, did demonstrate that a proper mechanical application of the water-spray method would give satisfactory results.

METHOD OF OPERATION AND CONTROL

Water Flow

Fig. 2 shows the construction of the perfected instrument now in use, together with its attachments to the burner and combustion chamber of a water flow calorimeter. The source of the water is connected to the inlet water tube (1) through which it flows to the inlet water chamber (2) from which it passes through orifices (3) in helical groove (4) of removable spray cylinder (5) in jets which tend to converge at the center line of the spray cylinder (5) where the water jets are broken to form a fog. The falling water is deflected by the roof of the air-mixing chamber (6) and flows to the water reservoir (7) from which it flows through the inlet to the water column and wick well (8) to overflow weir (9) thence to drain tube (10).

Air Flow

That part of the air which is to be treated in the spray cylinder (5) passes through the air control valve (11) down through spray cylinder (5) and enters the air-mixing chamber (6) through treated-air port (12), where it is mixed with the untreated air which enters the air-mixing chamber (6) through untreated-air port (13). The mixed, treated, and untreated air then passes from air-mixing chamber (6) through combustion air offtake (14) past shielded wet and dry bulb psychrometer (15) through swing joint (16) and burner housing connector (17) to the regular calorimeter burner and combustion chamber through special burner housing (18).

Psychrometer

Attention is directed to the table on the chart Fig. 1, which gives X_o, the relative humidity of the combustion air for zero correction for observed heating values H from 100

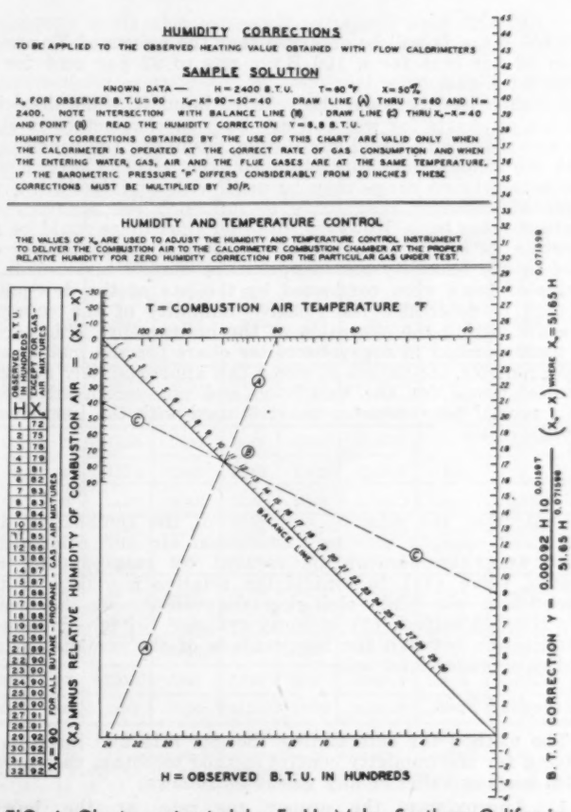
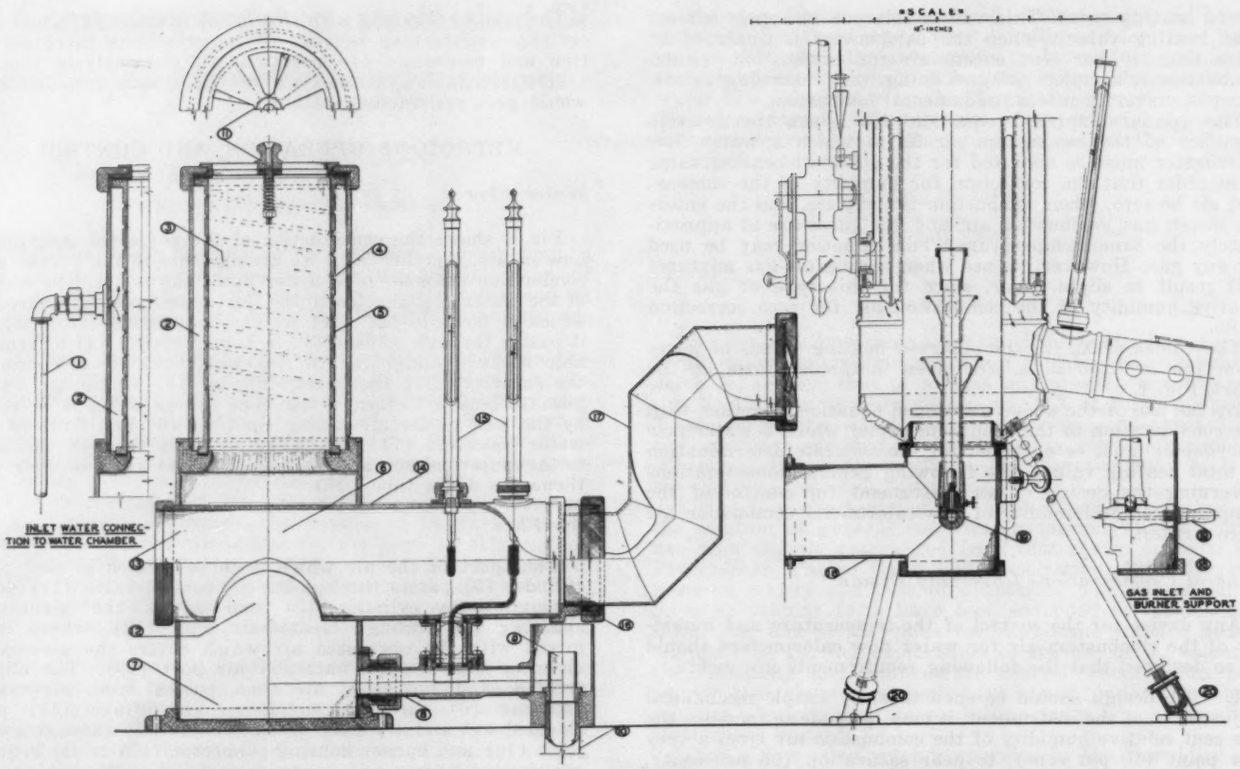

HUMIDITY CORRECTIONS
TO BE APPLIED TO THE OBSERVED HEATING VALUE OBTAINED WITH FLOW CALORIMETERS
SAMPLE SOLUTION
HUMIDITY AND TEMPERATURE CONTROL
T = COMBUSTION AIR TEMPERATURE °F
(Xo) MINUS RELATIVE HUMIDITY OF COMBUSTION AIR = (Xo − X)
BALANCE LINE
H = OBSERVED B.T.U. IN HUNDREDS
B.T.U. CORRECTION Y = 0.00092 H 10 0.01887 (Xo − X) WHERE Xo = 51.65 H 0.071998

FIG. 1. Chart constructed by E. H. Mohr, Southern California Gas Company, for the solution of McGlashen's Equation No. 7.



1. Inlet water tube.
2. Inlet water chamber.
3. Orifices in spray cylinder.
4. Helical groove in spray cylinder.
5. Removable spray cylinder.
6. Air mixing chamber.
7. Water reservoir.
8. Inlet to water column and wick well.
9. Overflow weir.
10. Drain tube.
11. Air control valve.
12. Treated air port to air mixing chamber.
13. Untreated air port to air mixing chamber.
14. Combustion air off-take to burner housing.
15. Shielded wet and dry bulb psychrometer.
16. Swing joint for burner housing connector.
17. Burner housing connector.
18. Special calorimeter burner housing.
19. Gas inlet and burner support.
20. Special calorimeter leg sockets.

FIG. 2. McGlashen air humidity and temperature controller with burner and combustion chamber attachments on a water flow calorimeter.

to 3,200 B.t.u. It will be observed that the values of X_o range from 72 per cent for a 100 B.t.u. gas to 92 per cent for a 3,200 B.t.u. gas.

A comparison between the relative humidities obtained by the use of charts for wet and dry bulb psychrometers in still air and those with rapid ventilation, results in the conclusion that the relative humidity obtained from either chart in the above mentioned range may be used without introducing an error of sufficient magnitude to influence the accuracy of heating value tests However, in order that there could be no question as to the accuracy of the special psychrometer as used in the humidity and temperature control instrument, a series of tests were conducted by the use of the dew-point method to determine the relative humidity of the combustion air during the operation of the instrument. This series of tests resulted in a psychrometer chart for the instrument psychrometer, the values of which fall approximately midway between those for the ventilated and non-ventilated types. This special psychrometer chart is used with the instrument psychrometer.

Control

Control of the relative humidity of the combustion air, and near equality between combustion air and calorimeter inlet water temperature is secured by manipulating air control valve (11) to control the relative humidity of the combustion air while changing the velocity at the water jets through orifices (3) in spray cylinder (5) to secure near equalization between the temperature of the combustion air and calorimeter inlet water.

Method of Test

The method for determining the gas rate and instrument setting for the humidity control method to obtain the correct total heating value of any gas is as follows:

1. Approximate the proper gas rate at the burner through observation of the flame characteristics before placing the burner in position in the calorimeter combustion chamber.

2. Place the burner in position in the calorimeter combustion chamber, and close the flue gas damper.

3. Check the flue gas for odor of incomplete combustion, and if odor is present, reduce the gas rate until odor disappears.

4. Open flue gas damper to insure complete combustion.

5. Connect the humidity and temperature control instrument to the special burner housing.

6. Adjust the humidity and temperature control instrument to deliver the combustion air to the calorimeter at, or near, saturation at the temperature of the calorimeter inlet water.

7. Determine the approximate heating value of the gas sample under the above conditions, and use that value to determine the correct relative humidity of the combustion air for zero humidity correction for the gas under test.

8. Adjust the humidity and temperature control instrument to deliver the combustion air to the calorimeter at the temperature of the calorimeter inlet water, and at the proper relative humidity for zero correction, and complete the test.

Comparison of Results of Operation

With the exception of Tests Nos. (14) and (15), each of the tests shown in Table No. 1, and numbered (1) to (17), inclusive, represent two determinations, one immediately following the other on the same gas sample, one without humidity and temperature control (Reg.) and one with humidity and temperature control (H.C.). In order that the reader may find it easier to observe the effect of humidity and temperature control, related values which concern the same factor are arranged in double columns numbered (1) to (9), inclusive. As an illustration, we will consider column 4, Test

No. (1), which shows that the difference between combustion air and calorimeter inlet water temperature was 4.0° F., without humidity and temperature control and only 0.5° F. with humidity and temperature control. Referring to column 6, we find that these temperature differences represent a correction of −3.0 B.t.u. without humidity and temperature control, and 0.0 B.t.u. with humidity and temperature control.

Column 6 gives the correction in B.t.u. that was applied for the difference between combustion air temperature and calorimeter inlet water temperature for the particular gas under test. The only corrections available for this condition are those for a gas of approximately 600 B.t.u. heating value. (Technologic Paper of Bureau of Standards No. 36, Page 81). Direct application of these corrections is erroneous when applied to the observed heating values of higher B.t.u. gases. Therefore, in the absence of a table of factors specifically prepared for the particular gas under test, it has been considered good practice to use a correction arrived at by multiplying the corrections given for 600 B.t.u. gas by the observed heating value of the gas under test, and dividing the result by 600. The corrections shown in column 6 were estimated by this method.

The reader's attention is directed to column 7, "Humidity Correction Without Humidity and Temperature Control." The humidity correction listed here is the correction that would be used for the gas under test when the test is made with the combustion air at the relative humidity indicated in column 5 and under conditions of equality between the temperature of combustion air, entering water, and flue gases, and exactly 40 per cent excess air in the flue gases. The writer recognizes the fact that the conditions under which these tests were made make it obvious that the application of these corrections is in error because the conditions upon which the corrections are based were not realized. The corrections are used here because they are the only ones available for use with the "humidity correction method," and because it has been the experience of the writer, that the conditions on which these corrections are necessarily based are seldom, if ever, exactly realized in industrial gas calorimetry.

With the exception of gas-air mixtures, the values of X_o given in chart shown as Fig. 1, were used to adjust the humidity and temperature control instrument at the proper relative humidity, to result in zero humidity correction for the particular gas under test. In the case of gas-air mixtures, the value of X_o is taken as 90. The values maintained at the instrument are recorded in column No. (5) under "Relative Humidity of Combustion Air, Humidity Controlled."

All tests shown in Table No. 1 were made with the gas metered at a pressure of 1.2 in. of water, and at the rate indicated in column 11.

It should be particularly noted that the rates listed in column 11 were used without any reason to believe that they would result in 40 per cent excess air in the flue gases at any of the damper settings listed in column 12. These rates were chosen by simply observing the flame characteristics and making certain that there was no odor of incomplete combustion in the flue gases. This was done in order to demonstrate the accuracy of the "humidity and temperature control method" under operating conditions which destroy the accuracy of the "humidity correction method."

Test No. 14 illustrates the method used to determine the heating value of any gas, with sufficient accuracy to enable the operator to determine the relative humidity at which the instrument must be operated, in order that the humidity correction be zero. This method is given above in detail under "Method of Test."

Test No. 15 shows the results of operation with the instrument set at the correct relative humidity, as determined by Test No. 14.

The accuracy, as well as the flexibility of this particular "humidity and temperature control method" is again proved, when we consider the fact that when testing gases ranging from a 611.5 B.t.u. commercial propane air mixture, through natural gases of several heating values to 2,548.3 B.t.u. commercal propane, the gas rate was changed only four times, i.e. only four burner orifice sizes were used, yet *accuracy was maintained regardless of damper setting.*

During the progress of these tests the writer was assisted by B. O. Cossey, Southern California Gas Co., who has had considerable experience with both the indicating and recording types of calorimeter. It is an important fact that he was able to perform these tests in such a manner as to obtain the degree of accuracy indicated although he had no previous experience with the humidity and temperature control instrument or with the particular arrangement of calorimetric equipment in use at this station.

TABLE NO. I. RESULTS OF THE OPERATION OF A WATER-FLOW CALORIMETER WITH AND WITHOUT HUMIDITY AND TEMPERATURE CONTROL OF COMBUSTION AIR HUMIDITY AND TEMPERATURE CONTROL INSTRUMENT NUMBER ONE.

(Corrections for humidity are from McGlashen's equation (7) corrected for gas-air-mixtures by using X_o=90. Instrument settings except for gas-air mixtures, McGlashen's equation (6).)

	1		2		3		4		5		6		7		8		9		10	11	12
	ROOM AIR		TEMPERATURE REGULAR TESTS		HUM. CONTROL		TEMP. DIFF. COMBUST. AIR		REL. HUM.		CORRECTIONS FOR				OBSERVED B.T.U.		TOTAL B.T.U.				
			COMBUST	INLET	COMBUST	INLET	INLET WATER		COMBUST. AIR		COMBUST. AIR		REL. HUM.		CORRECTED FOR		WATER-FLOW		CORRECT	GAS	
TEST NO.	REG.	H.C.	AIR	WATER	AIR	WATER	REG.	H.C.	REG.	H.C.	WATER T. DIFF. REG.	H.C.	COMBUST. AIR REG.	H.C.	COLUMN NO. 6 REG.	H. C.	CALORIMETER REG.	H. C.	TOTAL B. T. U. SAMPLE	RATE CU. FT. PER HR.	DAMPER SETTING
1	77	77	77.5	73.5	74.0	73.5	4.0	0.5	20	89	- 3	0	+ 8	0	602	610	610	610	611.5	6.5	CLOSED
2	77	77	77.5	73.4	74.0	73.5	4.1	0.5	20	88	- 3	0	+ 8	0	594	612	602	612	611.5	6.5	OPEN
3	77	78	75.5	72.9	73.5	73.0	2.6	0.5	18	85	- 4	-1	+11	0	987	995	998	995	994.5	3.5	CLOSED 1 HOLE
4	78	79	77.0	74.1	75.0	74.4	2.9	0.6	17	85	- 4	-1	+12	0	980	995	992	995	994.5	3.5	CLOSED
5	78	79	77.0	74.1	75.0	74.5	2.9	0.5	17	85	- 4	-1	+12	0	978	993	990	993	994.5	3.5	OPEN
6	70	71	68.5	68.0	68.5	68.0	0.5	0.5	17	85	- 1	-1	+10	0	1093	1101	1103	1101	1102.0	3.5	CLOSED
7	70	71	70.0	68.0	68.5	68.0	2.0	0.5	17	85	- 3	-1	+10	0	1086	1102	1096	1102	1102.0	3.5	OPEN
8	84	85	82.0	78.1	78.5	78.0	3.9	0.5	23	86	- 6	-1	+15	0	1130	1150	1145	1150	1149.0	3.5	CLOSED
9	84	85	82.0	77.2	78.0	77.3	4.8	0.7	18	86	- 7	-1	+16	0	1124	1148	1140	1148	1149.0	3.5	OPEN
10	81	82	81.0	77.0	77.5	77.0	4.0	0.5	36	86	- 6	-1	+12	0	1127	1142	1139	1142	1143.0	3.5	CLOSED
11	74	75	73.5	72.2	72.5	72.2	1.3	0.3	18	85	- 2	0	+14	+1	1190	1208	1204	1209	1210.0	2.6	CLOSED
12	74	75	74.5	72.2	72.5	72.2	2.3	0.3	18	85	- 3	0	+14	+1	1183	1206	1197	1207	1210.0	2.6	OPEN
13	75	76	75.5	73.2	73.5	73.3	2.3	0.2	22	92	- 5	0	+18	-1	1574	1603	1592	1602	1602.0	1.6	CLOSED
14	--	78	---	---	73.0	72.9	--	0.1	--	100	---	0	--	-3	----	2550	-----	2547	2548.3	1.6	CLOSED
15	--	72	---	---	71.5	71.8	--	0.3	--	90	---	0	--	0	----	2548	-----	2548	2548.3	1.6	OPEN 1/2
16	73	73	73.0	71.8	72.0	71.8	1.2	0.2	25	88	- 4	-1	+24	0	2518	2549	2542	2549	2548.3	1.6	CLOSED
17	73	73	74.0	71.8	71.5	71.8	2.2	0.3	25	95	- 6	+1	+25	-2	2501	2552	2526	2550	2548.3	1.6	OPEN

Tests No. 1 and 2; commercial propane–air mixture. Correct B.t.u. calculated from Tests No. 14 to 17 inclusive.

Tests No. 3, 4, 5; Natural gas (standard sample). Correct B.t.u. calculated from analysis; checked by flow and recording calorimeters.

Tests No. 8, 9, 10; Natural gas: correct B.t.u. from recording calorimeters.

Tests No. 11, 12; commercial propane-air mixture. Correct B.t.u. calculated from Tests No. 14 to 17 inclusive.

Test No. 14 to 17 incl.: Correct B.t.u. of commercial propane 2548.3 (saturated).

Note: "Reg."=Without humidity and temperature control. "H.C."=With humidity and temperature control.

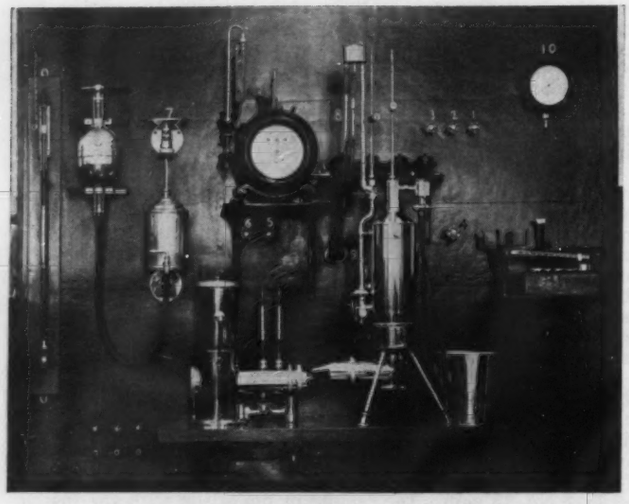


FIG. 3. Arrangement of the flow calorimeter and auxiliary equipment.

ARRANGEMENT OF CALORIMETRIC EQUIPMENT

During the prgress of the investigation resulting in this paper certain difficulties in operation caused by inconvenient arrangement of apparatus became apparent. Therefore, a more convenient method of operation and control of the flow calorimeter and its auxiliary equipment was developed which resulted in increased accuracy and a saving of time. This arrangement of equipment is presented herewith for the consideration of those who may encounter similar operation difficulties.

Fig. 3 shows the arrangement of the flow calorimeter and auxiliary equipment referred to in this paper. The arrangement is such that the important instruments which must be under almost constant observation during the entire period of test are grouped at eye level, while the instruments which do not require constant attention, are placed in such a position that their operation may be observed and adjusted without unnecessary movement or loss of time.

In order that this paper will not be needlessly extended, only a brief discussion of the important structural details of the set-up shown in Fig. 3 will be given.

With the exception of the calorimeter water storage tank, all of the calorimetric equipment and operating valves are mounted on a six-foot square panel. All piping, except the off-takes to the instruments, is mounted on the back of the panel.

Water Flow System

Since the temperature of the tap water is too variable and too different from that of flow calorimeter combustion air, city water is supplied through a half-in. brass pipe to a 180 gal. copper water storage tank secured to the "I" beams, which support the roof of the building. The water from the storage tank is passed through a half-in. horizontal pipe secured to, and extending across the back of the panel, Fig. 3. This pipe has two off-takes, one through the half-in. valve (4), to the three eighths in. chromium-plated copper tube (9), which is connected to the water intake of the flow calorimeter, and the other through the quarter-in. valve (5), to a three-eighths in. copper tube which is connected to the water inlet tube of the humidity and temperature controller.

In order that the humidity and temperature controller may be operated on either tap or tank water, tap water is passed through the quarter in. valve (6), to a second three-eighths in. copper tube which is also connected to the inlet tube of the humidity and temperature controller.

Overflow water from the upper and lower weirs of the flow calorimeter passes through separate three-eighths in. chromium-plated copper tubes (8), and (not shown) extending through the panel to a two-in. water drain pipe.

Water from the overflow weir of the humidity and temperature controller passes through a half-in. brass drain pipe extending through the panel to the two-in. water drain pipe.

Gas Flow System

Gas from the Thomas Recording Calorimeters, shown in Fig. 4, passes from each recording calorimeter manifold through a quarter-in. valve to a three-eighths in. copper sample line which terminates at the quarter-in. valve (1), Fig. 3, in a three-valve manifold secured to the back of the panel. Of the other two three-eighths in. copper lines terminating at quarter-in. valves on this manifold, valve (2), is on a sampling line from low pressure sample containers, and valve (3), is on a sampling line from special regulators on high pressure sample containers.

Gas from the off-take of the three valve manifold passes through three-eighths in. copper tubing at the pressure indicated by gage (1) to four dry regulators from which it passes back through the panel to a rubber tube connector extending through to the front of the panel. Connections between this connector and the inlet to the wet test meter are made with a three-in. length of rubber tubing.

Metered gas from the wet test meter is passed through a three-eighths in. copper tube extending along the back of the panel and terminating at both ends in rubber tube connectors extending through to the front of the panel. Connection between the meter and copper tube is made through a three-in. length of rubber tubing while the burner connection consists of an 18-in. length of rubber tubing lined with short lengths of copper tubing to limit the area of rubber exposed to the gas.

Standard Volume Bottle

The method of mounting the standard volume bottle and adjustable shelves used to determine the correct water level in the calorimeter wet test meter is indicated at (7), in Fig. 3. However, the construction of the adjustable shelves, as well as the connection between the standard volume bottle and meter, requires some explanation.

Each adjustable shelf for the standard bottle tank consists of a metal disc six in. in diameter. Attached to, and extending downward from the center of this disc, is a shaft with square threads. This shaft passes through a sleeve in the shelf bracket and enters a square thread nut which is free to rotate in a collar in such a manner that the shaft and shelf are moved on a vertical line through the sleeve, either up or down, depending upon the direction of rotation of the nut. The object of this method of adjusting the tank shelves is to provide an easier, quicker, and more dependable method of adjusting the tank with reference to the standard bottle so that the water comes to rest with the bottom of the meniscus at the proper index on the standard volume bottle at the beginning and end of the test.

The connection between the standard volume bottle and the wet test meter consists of a three-eighths in. copper tube with rubber tube connectors at each end. This tube passes from the outlet of the standard volume bottle to a point on the front of the panel two in. to the left of the wet test meter inlet. A rubber tube connection to this tube at the standard volume bottle is left in place. A short rubber tube connects the tube and meter inlet.

Suggested Equipment Improvements

During this investigation, it was also disclosed that one of the major obstacles in gas calorimetry is the determination of gas volumes under test. The wet type meter used was selected as the best of five meters of the same type, after carefully observing the operating characteristics of each meter. Certain suggestions for improvements in the construction of the wet type meters are therefore offered.

Wet test meters now in use deliver a slightly fluctuating flow of gas to the burner which results in increased variations in the temperature indicated by the calorimeter outlet thermometer. We find that some improvement is realized by removing the meter gear train to decrease resistance and obtain better balance.

There is some doubt that the meter thermometer bulb is placed in the proper position within the meter to indicate the true temperature of the gas under test.

It is suggested that there be constructed a special one-tenth cu. ft. meter for use with a flow calorimeter. Such a meter should be so constructed that it would not be required to do an appreciable amount of work in overcoming bearing friction or the resistance of other moving parts in order to minimize the pressure differential across the meter. The metering drum should be perfectly balanced in motion in

order that there be an even flow of gas to the calorimeter burner. The thermometer bulb should be so placed within the meter that it indicates the true temperature of the gas being measured.

Summary and Conclusion

Any investigation of the practices now followed for the determination of calorific values of gaseous fuels by the use of the water flow calorimeter, leads to the conclusion that satisfactory results cannot be obtained until methods of operation and equipment have been standardized to eliminate the necessity for large correction factors to make up deficiencies in method and equipment.

While it is true that the gas inspector should have available sufficient information to enable him to evaluate the effects of deviations from a standard procedure in any particular instance, such information should be used primarily as a guide in his efforts to improve equipment and methods of operation, and to correct for small deviations from a standard procedure.

This paper is not presented as a complete treatise on gas calorimetry. The information given herein has been found to be adequate to enable any operator who has been properly trained in the usual calorimetric procedure in a properly equipped calorimetric laboratory to change the method of test from the "humidity correction" method to the "humidity control" method.

This investigation to determine the efficiency and practicability of the different types of instruments and methods used in gas calorimetry has resulted in the development of a method and auxiliary equipment which increases accuracy and decreases the time of tests.

Since the accuracy of the method of operating a water flow calorimeter with the auxiliary equipment, as described in this paper, has been proved repeatedly under actual operating conditions in a station where from four to five Thomas Recording Calorimeters are in continuous operation, and since the results of approximately one hundred special tests on various gases under special operating conditions have added further proof of its accuracy, and since this method requires no calibration against other methods, it is presented as the most accurate basic method available for determining the total heating value of gaseous fuels.

Acknowledgments:

The writer wishes to make grateful acknowledgment to E. X. Schmidt, Cutler-Hammer, Inc., Milwaukee, *(Gas-Age Record*, Sept. 24, 1932, "Making Accurate Heating Value Determinations on Gases"); Francis Fahey, Brooklyn Union Gas Co. *(Gas-Age Record*, Aug. 12, 1933, "Effect of Atmospheric Humidity on Gas Calorimetry"), and M. A. Richford, Pacific Gas and Electric Co., *Proceedings*, P.C.G.A. (1934), whose published works have been drawn upon freely. Acknowledgment is also made to the engineers who reviewed this paper for helpful suggestions and constructive criticism.

DEFINITIONS PERTAINING TO CALORIFIC VALUE OF GASEOUS FUELS

British Thermal Unit (Mean B.t.u.): The mean British thermal unit or (M.—B.t.u.) is 1/180 of the amount of heat required to raise the temperature of one lb. of water from 32° F. to 212° F.

Standard Cubic Foot: A standard cubic foot is the amount of gas which would occupy a volume of one cu. ft. at a temperature of 60° F., if saturated with water vapor and under a pressure equivalent to that of 30 in. of mercury at 32° F. and under standard gravitational force.

Excess Air: Excess air is the amount of air above that required for theoretically complete combustion which passes through the combustion and flue space.

Products of Combustion: The products of combustion are the constituents resulting from the burning of gas with the oxygen of the air including inerts but excluding excess air.

Flue Gases: Flue gases are the products of combustion, plus excess air.

Observed Heating Value: The observed heating value for a water-flow calorimeter is the value obtained by multiplying the mass of water flowing through the calorimeter during the period of test by the corrected increase of the temperature of the water, and dividing by the volume of gas burned during the period, volume being expressed in standard cu. ft.

Net Heating Value: The net heating value of a gas is the number of mean British thermal units produced by the combustion, at constant pressure of one standard cubic foot of gas with air of the same temperature and pressure as the gas when the flue gases are cooled to the initial temperature of the gas and air and the water formed by combustion remains in vapor state.

Total Heating Value: The total heating value of a gas is the number of mean British thermal units produced by the combustion, at constant pressure, of a standard cubic foot of gas with air of the same temperature and pressure as the gas, when the flue gases are cooled to the initial temperature of the gas and air, and when the water formed by combustion is condensed to the liquid state.

DISCUSSION OF MR. McGLASHEN'S PAPER BY MR. MARK F. KLEEBERG AND MR. S. J. MODZIKOWSKI, PEOPLES GAS LIGHT AND COKE COMPANY, CHICAGO, ILL.

Before commenting upon some of the details encountered in this paper, it should be distinctly understood that we consider the paper to have outstanding merit and that we are in hearty agreement with the conclusions drawn from the contents of the article. It is with the idea of clarifying our conception of some of the matter contained in the paper that the following comments are offered.

FIG. 4.

Paragraph Four

It would probably be less general to confine the statement regarding the accuracy of the Thomas Calorimeter within the limits of industrial gas calorimetry. The gas calorimetry method used by F. D. Rossini of the National Bureau of Standards is generally conceded to be more accurate.

In order to prevent confusion in the matter of relative accuracies of flow and Thomas Calorimeters, statements of which have been found to be more or less opinionated, it would seem advisable to give either definite accuracy, precision, or reproducibility percentages for both types of instruments as operated under conditions inferred in the paper. A case in point may be taken from Table No. 1 "Results of the Operation of a Water Flow Calorimeter With and Without Humidity and Temperature Control of Combustion Air." In column 10, the value 2548.3 is given for the correct total B.t.u. of propane which we assume is pure. Yet Rossini gives a value of 2528 ± .58 B.t.u. on the same basis. Assuming that both gases were pure and that Rossini's value was the "truth" (i.e. 100 per cent accurate), then the method used in this paper for obtaining the correct total B.t.u. would be about 99 per cent accurate, although the reproducibility of the method may be 100 per cent. However, a summation of the possible errors for best attainable practice in flow calorimetry yields a value of about 1.10 per cent, even for a 600 B.t.u. gas. It is possible that the comparative figures of the two methods as listed in column 9 and the correct values listed in column 10 of Table No. 1 might cause misconception of the relative merit of the two methods in some minds.*

General

It seems unfair to the "humidity correction" method, whether it is that of W. A. McGlashen, E. X. Schmidt, F. Fahey, M. A. Richford, or the New National Bureau of Standards method given in Circular C-417, to compare it with the "humidity control" method unless the proper conditions for its application are maintained. The chart, Fig. 1, places the use of "humidity correction" methods in an unfavorable position. Inasmuch as each laboratory operator will have to decide on the type of method to be used, basing the decision upon accuracy, installation cost, and operating costs, it is probably unwise to even infer that one method is superior to another, unless complete data concerning the accuracy of the two methods are presented.

Possibly one of the best arguments in favor of the "humidity control" method is that it can be used as an officially recognized procedure for any gas, inasmuch as the procedure is recommended in the National Bureau of Standards Technologic Paper No. 36. Recently, however, the National Bureau of Standards has published new methods for determining heat loss corrections (Circular C-417) which are applicable to any gas.

It is our opinion that the accuracy obtainable with the "humidity control" method and the new "humidity correction" method should be the same under the conditions of best industrial practice. Therefore, if this is true, the decision of which method to use can be based upon a comparison of installation and operating costs. It is entirely conceivable that when all steps in operating with either method under best practice are considered, that one method might be less time consuming than the other. The results of such a comparison would prove very valuable to the industry.

We hope that these comments, in some slight measure, will help to clarify the present situation in regard to industrial gas calorimetry. Mr. W. A. McGlashen is to be commended for laying down these new avenues of approach to our ideal goal—the attainment of the highest possible accuracy for industrial gas flow calorimetry, both speedily and economically.

* The writer was in error in that he did not describe this gas as a "commercial propane" or a gas in which propane was the predominant constituent. This error, which appeared in the preliminary draft of the paper, was corrected before publication.—W. A. M.

The Economics of Oil Fogging

By J. LOUIS OBERSEIDER

and

R. G. HOLMAN

Southern California Gas Company

A SEARCH of the literature of the gas industry discloses a number of articles dealing with the problem of dust in gas. Reduced pipe line capacity (14); worn compressor piston rods, valves, rings and liners; cut out pressure reducing regulator valves; deposits on orifice meter plates (18); scored valves on positive displacement meters; plugged and eroded fittings; pilot outages and mal-functioning of complex control mechanisms on modern gas appliances (2); all are different aspects of the problem. Their repeated occurrence is responsible for the use of a variety of methods for either the removal or control of dust in gas transmission and distribution pipe lines. Some of these methods use equipment for blowing lines (6, 14); drip pots (13); expansion tanks (13); baffle chambers (13); centrifugal devices (3, 13); filters using steel or glass wool, sea moss, sheeps wool, oiled hair or excelsior and cotton or wire cloth (1, 9); oil or water contact cleaners (4, 8, 12, 13, 15); humidifiers (7, 15); and oil foggers (5, 7, 10, 11, 15, 16). Each method has its place depending upon the adaptability of the equipment to the particular job, the degree of removal or control desired, and initial and operating costs.

This report deals with one of these methods—oil fogging. The present treatment is limited in scope to the justification for oil fogging and the costs involved in its practice.

In combating the dust problem in distribution mains, the fact that each consumer's service must be protected, if removal or control of dust is to be considered effective, limits the methods to blowing lines, humidification, oil fogging and the use of small gas cleaners, usually of the filter type.

Since the autumn of 1935, the Research Department of the Southern California Gas Co. has worked on the development of oil fogging equipment and practice. During this period the distribution mains were oil fogged in a number of areas where the constant effort to maintain satisfied customers and promote better public relations, together with the cost of keeping a clean distribution system and supplying clean gas to modern appliances and equipment, constituted a real problem during cold weather. On the basis of the results obtained, until better methods are developed, the practice of oil fogging will be justified as a means for converting gas main dust into such a form that trouble will be reduced to a minimum.

Costs

A constant effort has been made to develop the most economical type of oil fogging installation from the standpoint of initial equipment costs and operating expense. Up to the present time, the fogging of distribution mains has been done most economically with a "low pressure" type nozzle (Fig. 1) installed as shown in Fig. 2. The installation is made in a district governor vault where gas from the high pressure side of the regulator can be used to atomize and carry oil into the low pressure side.

The "low pressure" type nozzle costs approximately $23.00 to make, $2.00 for materials and the remainder for labor. This cost varies somewhat with certain dimensions of the nozzle and the location of the oil injection needles that depend on the conditions under which the nozzle is to operate.

Nozzle Dimensions

1. *Length:* Since the nozzle is usually passed through a 1¼-in. gate valve or gas service cock located in the center of the dead end of the outlet main in the governor vault (see Fig. 2), the nozzle should be of sufficient length to inject the fog into the center of the gas stream and in the direction of gas flow. The gas from the regulator enters the main through a vertical riser and the nozzle does not have to extend beyond the center line of this riser. The length of the body

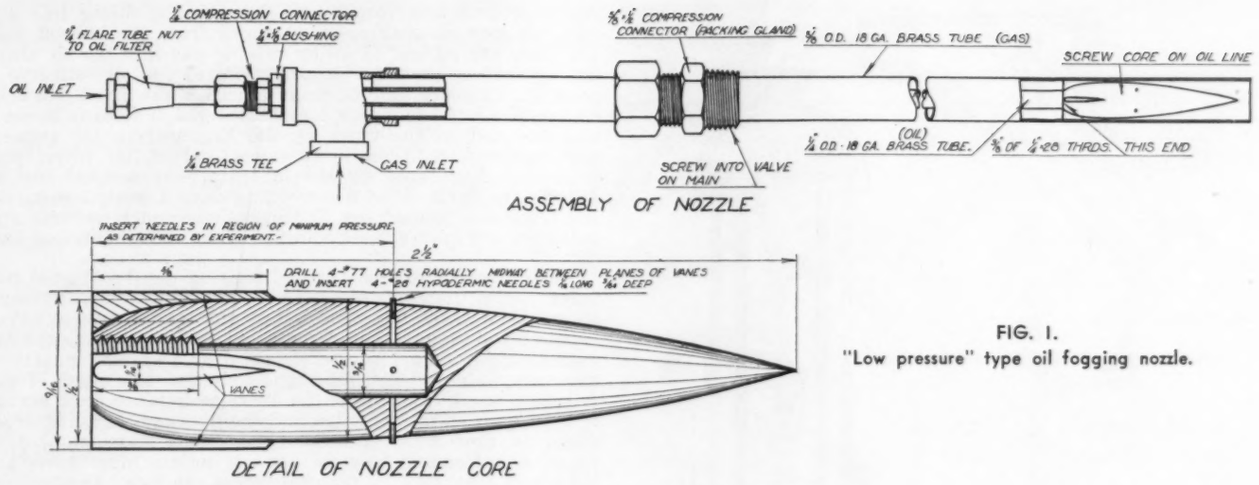

1/4 COMPRESSION CONNECTOR
1/4 FLARE TUBE NUT TO OIL FILTER
1/4 x 1/8 BUSHING
5/8 x 1/4 COMPRESSION CONNECTOR (PACKING GLAND)
5/8 O.D. 18 GA. BRASS TUBE (GAS)
SCREW CORE ON OIL LINE
OIL INLET
1/4 BRASS TEE
GAS INLET
SCREW INTO VALVE ON MAIN
1/4 O.D. 18 GA. BRASS TUBE. (OIL)
3/8 OF 1/4-28 THRDS. THIS END
ASSEMBLY OF NOZZLE
INSERT NEEDLES IN REGION OF MINIMUM PRESSURE AS DETERMINED BY EXPERIMENT:-
2 1/2"
DRILL 4-#77 HOLES RADIALLY MIDWAY BETWEEN PLANES OF VANES AND INSERT 4-#28 HYPODERMIC NEEDLES 1/4 LONG 3/64 DEEP
VANES
DETAIL OF NOZZLE CORE

FIG. 1.
"Low pressure" type oil fogging nozzle.

of the nozzle, then, should be equal to the distance from the center of the riser to the outer face of the valve plus the effective length of the packing gland and its bushings.

2. *Diameter:* The 5/8-in. O. D. brass tube was chosen arbitrarily for its rigidity. By reducing the tube size and core diameter and retaining the same annular area, the width of this annular space is increased and better thermodynamic performance can be had. Without altering the design, however, too great a reduction in diameter would restrict the atomizing gas passages.

3. *Core:* The form of the core was determined by analysis of nozzle characteristics and experiment. A high suction at the point of oil injection is necessary since high gas velocities and oil suction are desired. Larger size needles may be used with less pressure drop and less plugging without seriously affecting the efficiency.

4. *Oil Line:* One-quarter in. O. D. brass tubing was chosen because of its rigidity as well as a generous internal section for the passage of the oil. The first nozzles had the 5/8-in. brass tube soldered to the 1/4-in. brass tee. This required a large extra length of oil tube between the oil filter nut and oil tube connector in order to expose the core when servicing. A later development involved threading the 5/8-in. brass tube to the 1/4-in. brass tee. To remove the core from the oil tube simply unscrew it and slide it over the core. The exposed section of the oil tube need not exceed 1/2-in.

Position of Injection Needles

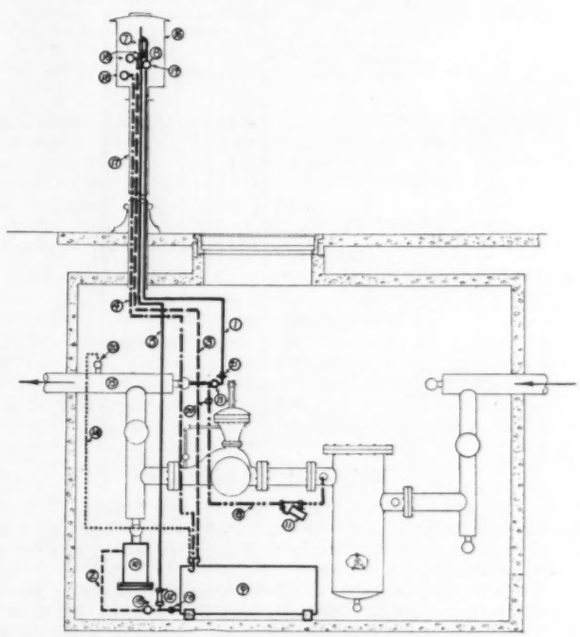
To find the position on the core at which a maximum suction exists, the entire nozzle is constructed as shown in Fig. 1 except for the needles and an excess of oil tube. The tip of the core is placed even with the end of the nozzle and a No. 70 hole is drilled into the wall of the 5/8-in. brass tube just above the location where the maximum suction is expected. From experience one may expect it to be within 1/2-in. of the throat on the discharge side of the core. A 1/4-in. tube is soldered over this drilled hole. The nozzle is arranged to discharge its gas into a suitable tank in which the pressure is kept equal to the pressure in the main for which the nozzle is being constructed. The suction in the nozzle tube at the No. 70 drilled hole is measured by connecting the soldered tube to one end of a mercury U gage; the other end is connected to the tank.

Curves are drawn from data of suction for various positions of the core at different inlet pressures and constant discharge pressure. During these tests care must be taken to keep the core from rotating since the drilled hole should lie in a plane midway between the planes of the core vanes. The nozzle is removed and the core is set at the most desirable position as determined by the curves. The 1/4-in. soldered test connection is removed and the core is marked with a No. 70 drill through the hole in the nozzle tube; this hole is then soldered.

The core is removed, the remaining three holes are marked and drilled and the needles installed. The nozzle may be tested again by transferring the test connection to the oil tube. Not more than 10 per cent reduction in suction should occur due to the presence of the needles in the rapidly moving gas stream.

If the core protrudes too far into or out of the nozzle, the test hole should be changed and a second set of curves obtained. Note that the position for the needles has been shifted.

The "low pressure" type nozzle is protected against plugging with dust that might be in the atomizing gas by installing a filter (Fig. 3A) in the atomizing gas line. This line delivers gas from the outlet side of the conventional dust trap to the gas inlet to the nozzle. If there is no dust trap, or if a pressure drop of 0.5 lbs. per sq. in. is not permissible, a filter having a larger filtering area (not less



(1) Oil supply to nozzle 1/4-in. tube.
(2) Drips return to storage tank.
(3) Oil filling line 3/4-in. tube.
(4) Oil blow-off line 1/4-in. tube.
(5) Oil line to flow meter 1/4-in tube.
(6) Gas line to nozzle 1/2-in. pipe.
(7) Oil flow meter.
(8) Oil flow control valve.
(9) Oil storage tank.
(10) Settling tank.
(11) Gas filter.
(12) Primary oil filter.
(13) Oil fogging nozzle.
(14) Oil storage tank pressure line.
(15) Gas main to be fogged.
(16) Gage box.
(17) Gage box post.
(18) One-fourth-in. gate valve.
(19) One-fourth-in. needle valve small orifice.
(20) One-half-in. gas cock.
(21) Secondary oil filter.

FIG. 2. Installation of "low pressure" type nozzle and auxiliary equipment.

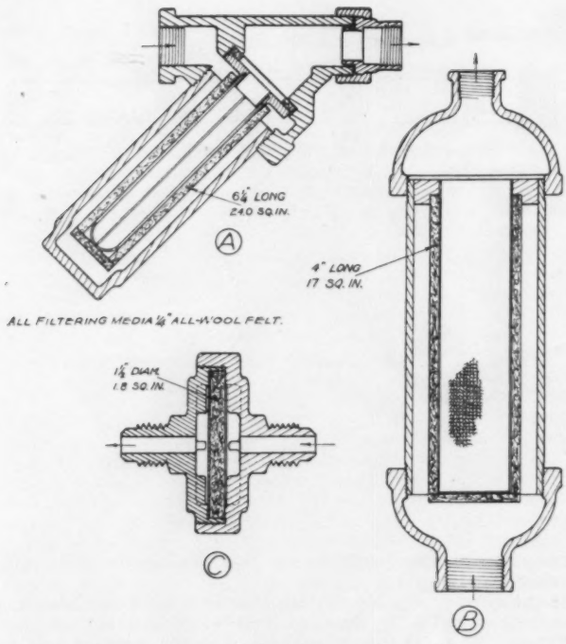


FIG. 3. (A) Gas filter. (B) Primary oil filter. (C) Secondary oil filter.

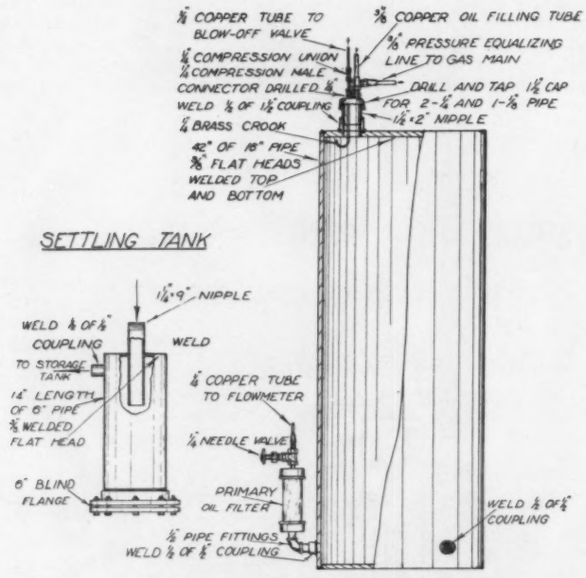

⅛" COPPER TUBE TO BLOW-OFF VALVE
⅜" COPPER OIL FILLING TUBE
¼" COMPRESSION UNION
¼" COMPRESSION MALE CONNECTOR DRILLED ⅛"
WELD ⅛ OF 1½" COUPLING
¼" BRASS CROOK
42" OF 18" PIPE
⅜" FLAT HEADS WELDED TOP AND BOTTOM
⅜" PRESSURE EQUALIZING LINE TO GAS MAIN
DRILL AND TAP 1½" CAP FOR 2-½" AND 1-⅛" PIPE
1½"×2" NIPPLE
SETTLING TANK
1¼"×9" NIPPLE
WELD ¼ OF ¼" COUPLING
WELD
TO STORAGE TANK
14" LENGTH OF 6" PIPE ⅜" WELDED FLAT HEAD
⅛" COPPER TUBE TO FLOWMETER
¼" NEEDLE VALVE
6" BLIND FLANGE
PRIMARY OIL FILTER
½" PIPE FITTINGS
WELD ½ OF ¼" COUPLING
WELD ½ OF ¼" COUPLING

FIG. 4. Oil storage and settling tanks.

than one sq. in. to every four cu. ft. of gas per hour at eight in. water column) must be used. The filter shown in Fig. 3A can be purchased for $1.45.

The nozzle is also protected from foreign matter in the oil by installing a primary filter (Fig. 3B) in the oil line to the flowmeter and a secondary filter (Fig. 3C) at the oil inlet to the nozzle. The former can be made for $1.55 and the latter can be purchased for $1.60.

Oil storage and settling tanks are shown in Fig. 4. They are made by the Engineering Department for $26.30 and $4.40 respectively. The flow of oil from these tanks to the nozzle is indicated on a flowmeter (Fig. 5) that can be made in the laboratory for $7.05. Copper tubing and pipe for oil and gas lines, together with valves, gas cocks, copper tubing fittings and pipe fittings, cost about $13.30 for the average installation.

The servicing of the oil foggers is done from a pickup truck. The oil supply in the underground storage tank is replenished from above ground by connecting the oil filling line to a calibrated tank (Fig. 5) by means of an oil resistant hose and forcing oil through the filling line and into the storage tank until oil flows from the blowoff line. The lines are purged of oil by valving gas into the oil filling line so that an accurate measurement of the oil delivered is possible. Pressure can be maintained in the truck tank by means of a hand pump or compressed gas. The tank is made and mounted on the truck by the Engineering Department and equipped with oil level gages, valves, oil filter, pipe fittings and oil hose by the laboratory at a total cost of $54.26. On the basis of five working days a week, one servicing truck can be used for 25 foggers since each unit requires attention but once a week and five units can be serviced each day.

The operating expense for oil fogging can be divided into three parts: namely, preparation, transportation and servicing. Experience has shown that one man-hour per day is required for preparation of materials and equipment and one man-hour per fogger for servicing. For a system containing approximately 200 district regulators and 175 miles of distribution trunk line, where the average distance from station to field location is 5½ miles and the average servicing truck speed is nine miles per hour, the maximum number of foggers that can be serviced per day by one man is five and the hours consumed by transportation are two. At $0.75 per hour, the labor per fogger during the operating period

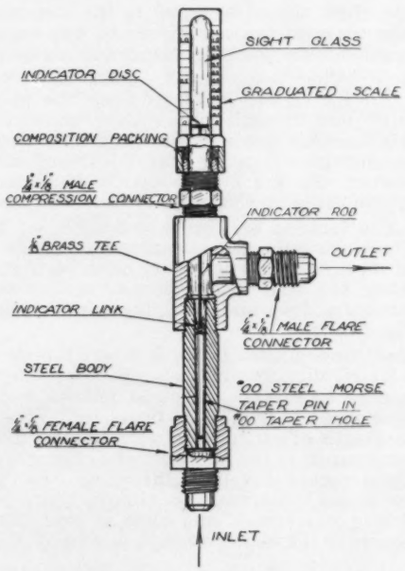


FIG. 5. Oil flowmeter.

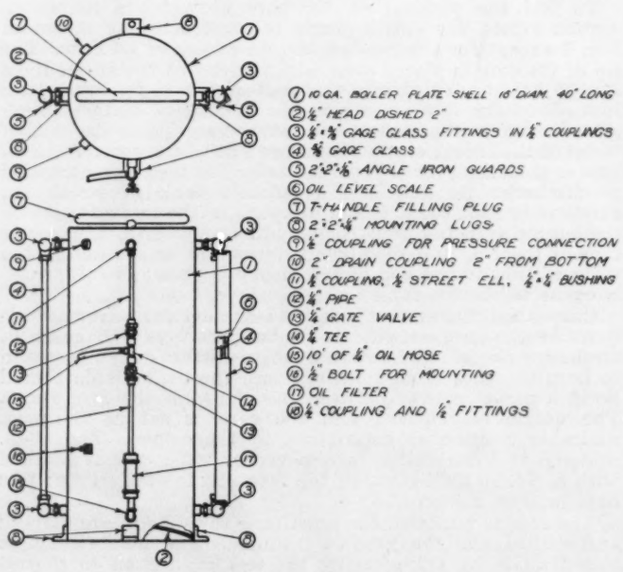

1 10 GA. BOILER PLATE SHELL 16" DIAM. 40" LONG
2 ½" HEAD DISHED 2"
3 ¼"×⅜" GAGE GLASS FITTINGS IN ¼" COUPLINGS
4 ⅜" GAGE GLASS
5 2"×2"×⅛" ANGLE IRON GUARDS
6 OIL LEVEL SCALE
7 T-HANDLE FILLING PLUG
8 2"×2"×⅛" MOUNTING LUGS
9 ¼" COUPLING FOR PRESSURE CONNECTION
10 2" DRAIN COUPLING 2" FROM BOTTOM
11 ¼" COUPLING, ½" STREET ELL, ¼"×¼" BUSHING
12 ¼" PIPE
13 ¼" GATE VALVE
14 ¼" TEE
15 10' OF ¼" OIL HOSE
16 ½" BOLT FOR MOUNTING
17 OIL FILTER
18 ¼" COUPLING AND ½" FITTINGS

FIG. 6. Servicing truck tank.

TABLE NO. I—SUMMARY OF OIL FOGGING COSTS

Item	Cost				
Oil fogger equipment	Over-head	Mate-rial	Labor	Total	Total per Fogger
"Low pressure" type oil fogging nozzle		$2.05	$20.75	$22.80	
Gas filter		1.45		1.45	
Oil filter, primary		.80	.75	1.55	
Oil filter, secondary		1.60		1.60	
Oil storage tank	$2.90	13.50	9.90	26.30	
Settling tank		1.40	3.00	4.40	
Oil flowmeter		1.00	6.05	7.05	
Copper tubing, ¼ in. (75 ft.)		2.50		2.50	
Copper tubing. ⅜ in. (25 ft.)		1.35		1.35	
Pipe, ½ in. (10 ft.)		.40		.40	
Valves, gas cocks, copper tubing fittings and pipe fittings		9.05		9.05	
Total oil fogger equipment				$78.45	$78.45
Installation			12.00	12.00	12.00
Servicing truck equipment					
Oil supply tank	9.00	8.80	24.00	41.80	
Expansion tank water gage fittings, two pair		2.90		2.90	
⅝ in. x 36 in. gage glasses (2)		1.05		1.05	
Oil resistant rubber hose and fittings		2.30		2.30	
¾ in. x 9 in. galvanized funnel		1.65		1.65	
Oil filter, primary type		.80	.75	1.55	
Valves, cocks, and pipe fittings		2.99		2.99	
Total servicing truck equipment				$54.26	$2.17
Operating*					
Preparation			3.25	3.25	
Transportation		3.75	6.50	10.25	
Servicing		5.05	16.20	21.25	
Total operating				$34.75	$34.75
Supervision and repairs*			$25.95	$25.95	$25.95

* For 5-month period.

(October to February, inclusive) amounts to $25.95. Transportation at $0.048 per mile and fogger oil at $0.0307 per gal., add $8.80 more.

Supervision and repairs cost about $25.95. A summary of all costs appears in Table No. 1.

Justification

A large scale experiment was carried out for the purpose of determining whether or not oil fogging distribution mains could be justified on the basis of a substantial reduction in customer service orders due to dust. The lines in an area that had a high density of orders for a number of winters were oil fogged from the two district governor locations supplying the area, and from two locations within the area. No gas entered these mains from sources other than the two governors.

The original plans were to protect the two district governors and their distribution mains from dust in the incoming gas by installing oil contact cleaners (scrubbers) ahead of the regulators. This procedure would permit the study of one variable at a time. If oil fogging proved to be effective on dust already in the distribution mains, then experiments were to be run in areas unprotected by scrubbers to show whether or not fogging is also effective on dust entering distribution lines. These plans were changed to such an extent that no distinction could be made between the effect of fogging on dust in the incoming gas and dust already in the lines. The reason for the change was the fact that scrubbers were not available for the chosen area and a suitable location protected by a scrubber could not be found.

Fig. 7 shows the effect of oil fogging this area on the number of customer service orders judged to be due to dust. The customer service order data were obtained from the files of the Investigation Section of the Customers Department. While in most cases the orders did not specifically state the cause of trouble, with skill gained through experience, they were so carefully classified that, even though absolutely all were not due to dust, the totals were comparable. Data for January and February, 1936, were included because no oil fogging took place during that period, and because degree days and sendout were more nearly like those for the first two months of 1938 than the abnormal figures for the cold January and February of 1937.

A comparison between periods of no dust control and periods of oil fogging showed:

1. In January and February, 1938, customer service orders judged to be due to dust were only one-third of what they were in the same periods of 1936 and 1937.

2. There were approximately 550 customer service orders (96 per cent pilot outages) due to dust during the 1936-37 season (November to February, inclusive). At an estimated cost of $1.00 per order the total cost would be $550.00. This figure would, in all probability, have been higher had it not been for the fact that the area was oil fogged from January 27, 1937 on, and there were subsequently fewer service orders. Even this low figure would show a saving of $245.00 due to operating two oil foggers for the four months, assuming a two-thirds reduction in orders.* This would be enough to write off the equipment and installation costs and still show a saving of $60.00. One might argue that the 1936-37 season was unusually cold and the number of orders due to dust were high. However, if dust removal or control is neglected, a like or increased number can be expected in the future due to the more widespread use of modern appliances with their complex control mechanisms dependent on continuous functioning of pilot lights.

A comparison of oil fogging costs with those of the other methods—blowing lines, humidification and domestic gas cleaners—suitable for the removal or control of dust in distribution mains showed:

1. That blowing mains and services in such a manner as to remove practically all dust would involve high labor costs. At an estimated 80 man-hours per 500 ft. of pipe per day for the approximately 33 miles of main in the experimental area and an estimated one-half man-hour per service for roughly

* [550.00 × 0.67 − 2 (2.17 + 34.75 + 25.95)]

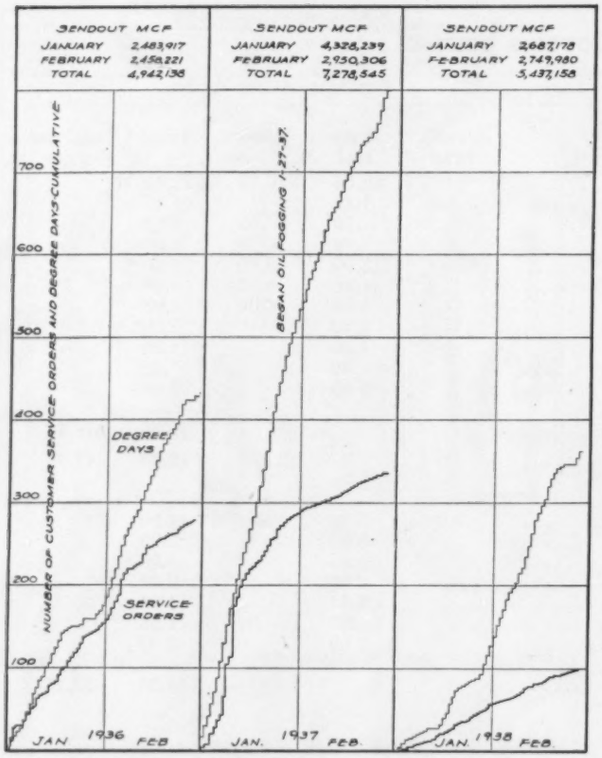


FIG. 7. Effect of oil fogging on customer service orders due to dust.

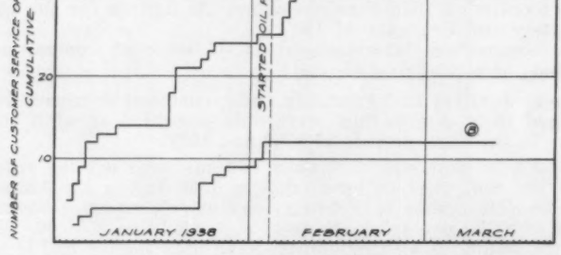


FIG. 8. Comparison of fogged and unfogged districts supplied by same trunk line.

7900 services, a total of 32,000 man-hours—costing about $24,000.00—would be required. To this has to be added the fixed charges on equipment such as portable dust traps (6), tools, etc.; the cost of maintenance and repairs; and the expense of transportation. A point to be kept in mind in the use of this method is the fact that the velocity is at a maximum where the line is discharging and diminishes to an appreciably lower velocity at the district regulator supplying this line. Since the ability of the gas to blow out dust is in direct proportion to the square of the velocity, the effect of blowing a line does not reach back very far from the outlet, and therefore a great deal of dust will remain in the lines unless relatively short sections are blown at a time. The blowing of such short sections should not be confused with the less expensive, but less efficient methods of blowing transmission lines from a compressor station to a distant holder.

2. That, on the basis of 0.2 lbs. of steam—at $0.34 per 1000 lbs. injected per M c.f. of gas, steam for humidifying the approximately 567,000 M c.f. per year fed to the experimental area would cost about $40.00. When fixed charges for equipment that costs about $2700.00 for a capacity of 600 M c.f. of gas per hour at 0.2 lbs. of steam per M c.f. are added, the total costs exclusive of labor will exceed those for oil fogging. One should remember that, while humidification might convert dust into such a form that it no longer causes trouble, oxygen would be introduced along with the water vapor, setting up conditions favorable to corrosion. In addition to this, wide variations in the relative humidity of the gas are liable to unfavorably affect meter accuracy.

3. That the cost of installing domestic gas filters on the estimated 7900 meters in the experimental area would amount to approximately $7900.00 in labor and $11,500.00 in equipment.

In addition to the evidence gained in the experimental area in favor of oil fogging distribution mains subject to dust trouble, data were obtained in six other areas that were oil fogged. Exceptionally accurate customer service order data for one of them are shown in Fig. 8. In this area dust in distribution lines fed from a number of the district governors had been causing customer service orders with regularity during cold weather. Finally, an oil fogger was installed at one of these governors and, as shown in the figure, trouble ceased in the territory supplied by this governor while it continued elsewhere.

The work done to date leads to the conclusion that, until better and more economical methods for the removal or control of dust in distribution mains are found, oil fogging can be justified on the basis of substantially reducing customer service orders due to dust.

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Measurement of Leakage From High Pressure Distribution Systems

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TO the Distribution Engineer who is responsible for the control of leakage one of the chief obstacles in the way of a satisfactory handling of this function has always been the lack of a cheap and accurate method of measurement of the leakage in any selected section of the distribution system. It is possible, of course, to obtain an accurate measurement in any small district by isolating the mains to be tested and passing the gas through meters after shutting off the supply to all customers supplied from these lines. Such measurements are actually being made on an extensive scale in connection with the leakage elimination operations of some companies; however, this program has the disadvantage of being relatively expensive and in those cases where the leakage is small the saving to be made by an elimination program is barely enough to justify the cost of actual repair work and will not warrant any substantial amount of testing and measurement expense. An additional important objection is the inconvenience to customers which necessarily results by reason of the shutting off of their supply during the period of test.

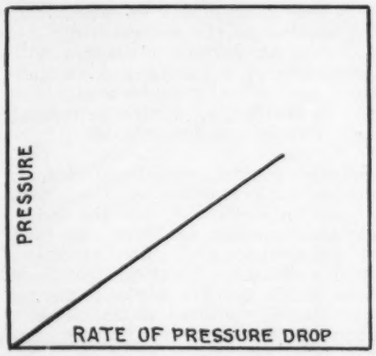

FIG. 1. Leakage test on underground line, theoretical relation of pressure drop to effective pressure (Leakage only).

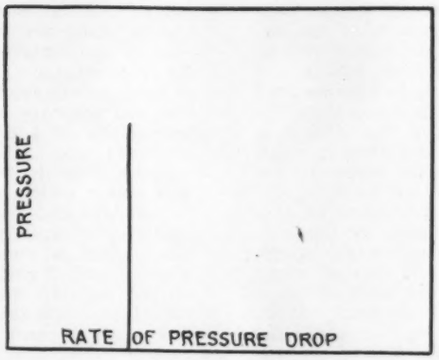

FIG. 2. Leakage test on underground line, theoretical relation of pressure drop to effective pressure (use by customer only).

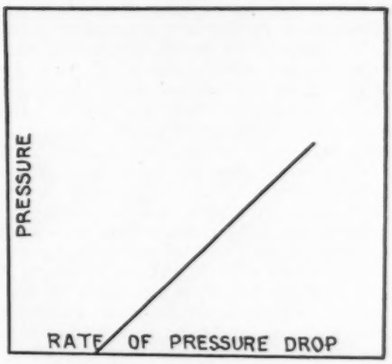

FIG. 3. Underground leakage test, theoretical relation of pressure drop to effective pressure (leakage plus customer's use).

In districts supplied under high pressure it is quite simple to measure the total output from the system, including both the leakage and the gas used by customers, by the pressure drop method, shutting off the supply for a short period and computing the volumetric equivalent of the measured pressure loss during this interval. In past years we have made some use of night pressure drop tests in Portland to obtain a rough idea of the relative leakage in various parts of our high pressure system, but unless the services affected are shut off it is necessary, in order to arrive at an approximation of the leakage, to estimate the proportion of the total output which is due to actual consumption by customers, and the unreliability of such estimates is obvious.

The ease with which such tests can be made, however, suggested to us that we would have the desired cheap and accurate method of leakage measurement if we were able to devise some simple mathematical means of separating the customers' usage from the total output indicated by the pressure drop test. A little consideration of the subject showed that such a separation was not at all difficult, and we have evolved a method which has given us very satisfactory results.

The basis of this method of separating the two components of the gas output from the section under test is the fact that the leakage from underground lines varies in direct proportion to the gage pressure. The original series of tests establishing this relation was described in a paper presented by the writer at a regional meeting of the Pacific Coast Gas Association in 1928. (*P.C.G.A. Proceedings*, Vol. 19, p. 459.) It was brought out at that time that the deviation of the rate of underground leakage from that which would be expected on the basis of the ordinary orifice flow formula is due to the fact that the resistance of the surrounding soil to the passage of the gas is a controlling factor in determining the amount of leakage which will take place. Mathematical considerations indicate that the quantity of gas flowing against the resistance of the soil will be directly proportional to the effective pressure, and this relation is definitely substantiated by experiment.

In view of this proportionality between leakage and pressure it is clear that the leakage component of the total output during a pressure drop test should vary with the pressure as a straight line function. On the other hand, the individual customer's regulators will keep the amount used by these customers practically constant regardless of the variation in main pressure through the comparatively small range needed for test purposes. If we assume a situation where the entire output is due to leakage and plot the rate of pressure drop against the gage pressure we will obtain a theoretical curve similar to that of Fig. 1, which will be a straight line passing through the origin of the coordinate system. A pressure drop test on a system in which there is no leakage and the entire load is due to consumption by customers will give a curve similar to that in Fig. 2, which represents a constant rate of pressure drop independent of the effective gage pressure. In the ordinary case however, there will be both leakage and customer usage, and the curve will be similar to that in Fig. 3. Here the point of intersection of the curve with the horizontal axis represents the theoretical condition which would prevail when the leakage is zero, and the value thus obtained is a measurement of the gas being used by customers. The difference between this figure and the total output at any pressure is the leakage at that pressure.

This method may be mathematically described as a graphical solution of the equation $T=C+PL$, where T represents the total output from the system, C is the consumption by customers' appliances. P is the gage pressure and L the rate of leakage per unit of pressure. At the point where P is zero the equation becomes $T=C$. If we could be certain that all of our observations were accurate it would only be necessary to measure the output at two different pressures and solve the two simultaneous equations thus obtained, but the graphical method is advantageous in that it enables us to base our results on a larger number of observations and therefore minimizes the importance of an error in any particular observation.

For our test work we use an ordinary 15-lb. recording gage which has been speeded up so that it makes one revolution of the chart in about an hour. We have found, however, that a faster gage could be used to advantage, particularly in testing short sections of main, and we intend to have a gage constructed with a chart speed four or five times that of the present instrument. The faster chart is expected to be of advantage because of the additional facility with which it can be read. In order to plot a curve similar to the theoretical curves of Figs. 1 to 3, we have found it convenient to check the number of time divisions on the chart required for each pound or half pound drop in pressure, and then to interpret these figures into pounds drop per hour by means of a table. Figs. 4 and 5 are typical test charts.

Figs. 7 and 8 are curves plotted from the data obtained from the charts, Figs. 4 and 5 respectively. It will be noted that Fig. 7 is similar to the theoretical curve Fig. 1, and represents a situation where all of the output during the test was due to leakage. In Fig. 8 we have the more general condition of a combination of leakage and use by customers. The deviations of some of the plotted points from the established straight line function are typical of the results obtained with our present equipment and are due to inability to read the chart more closely. This condition would undoubtedly be improved by a faster gage; however, there is not a great deal of advantage to be gained as the present errors are easily balanced out by using the midpoints between the plotted points rather than the points themselves. These midpoints show a very close correspondence with a straight line.

These curves establish the amount of leakage in terms of pounds pressure drop per hour. To convert this figure to cubic feet per hour it is only necessary to multiply by the volumetric capacity of the system under test and divide by 14.7. Generally the length and size of the lines under test can be easily obtained from the records and, the conversion to cubic feet per hour is therefore reasonably accurate. The tests represented by the charts in Figs. 4 and 5 are both single block tests on one inch mains and the leakage is found to be 11.3 cu. ft. per hour and 7.7 cu. ft. per hour, respectively, at a pressure of 14-lb. per sq. in. In our work the average pressure in each district is estimated annually, and this average is used as the reference pressure for all tests within the particular district. This practice enables us to appraise each leak on the basis of the actual contribution which it makes toward our total unaccounted for gas figure.

From the description of the test program which has been given thus far it is apparent that the accuracy of the results, outside of possible instrumental or personnel errors, depends on the validity of two assumptions which are inherent in the method used. It is necessary to assume that the customers or their automatic controls do not change the appliance valve settings during the period of test and it is also necessary to assume that the flow in the lines is small enough that the pressure is uniform in all parts of the system under test. In the case of single block tests or district tests involving only a relatively small number of customers we have found that any change made by the customers in their use of gas is easily recognized on the charts, and we are able to get satisfactory tests not only at night but during the off peak hours of the day as well. When a larger district is under test, however, it is necessary to do the work at night in order that the assumption as to the uniformity of pressure may be valid. As the size of the district increases, the probability that the load will remain uniform also decreases and, because of this factor, the measurement becomes more and more an approximation as the number of consumers involved increases.

Fortunately, however, the degree of accuracy of the results is automatically indicated by the graphic method of analysis of the test data If the assumptions on which the test is based are valid, the plotted points representing the rate of output from the system at various pressures will lie on a straight line. Conversely, if a substantial number of such points are established and actually lie on a straight line, the accuracy of the test is verified, as the mathematical probability of such a result happening accidentally is exceedingly small.

Quite often in testing a large district, variations in load will occur which situation makes evaluation of the chart impossible, and the test must be discarded, but the great majority of such tests are good enough to serve our purposes, and a substantial proportion are quite accurate. Figs. 6 and 9 are the chart and curve obtained from one of the regular weekly tests which we are making during the night hours on one branch of our system which includes 338 miles of main and about 18,000 services. In this case it was found that out of a total pressure loss of 2.47 lbs. per sq. in. per hour at five lbs. gage pressure, 1.30 lbs., equivalent to 4180 cu. ft. per hr., was due to leakage and 1.17 lbs., representing 3760 cu. ft. per hour was actual usage by customers.

The time required to make each test depends on the number of valves which must be closed to isolate the section to be tested and the availability of risers or other structures to which connections can be made. Under the most favorable circumstances we are able to make about 10 of the single block tests in one eight-hour shift at night. The minimum cost of these tests is therefore about $1.25 if two men are used or $.75 if the test is carried out by one man. Thus far we have assigned two men to the test work in order to be prepared for unforeseen contingencies, but after we are past the experimental stage it is probable that we will handle most of the tests with only one man. The tests on the major branches of our high pressure system are made at the pumping station by the regular operator on duty and therefore involve no expense. Other district tests usually involve three or four hours time of two men.

The principal limitation to the use of this leakage measurement method in the Portland system is the lack of suitable valves in the older lines. The majority of the older valves in the system are gate valves, and we have found that the probability of getting a satisfactory test by using these valves is very small. We do have a number of plug cocks, however, on the smaller mains, and as we are using lubricated plug valves exclusively for replacement purposes, we are gradually increasing the field of use of our testing method. Most of our line valves except those on the smaller mains are already provided with test risers on each side, and this facilitates making the necessary connection to the pressure gage.

Our district tests are being used principally as a means of scheduling our leakage elimination work to those locations where the possible results are the greatest. Occasionally also a leak of considerable magnitude shows up on

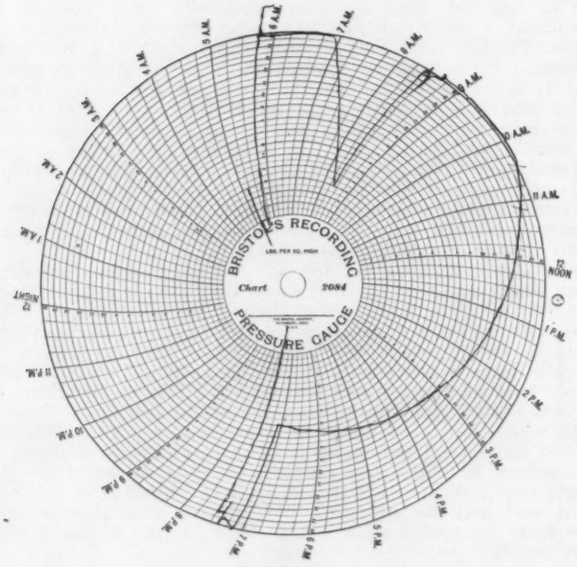

FIG. 4.

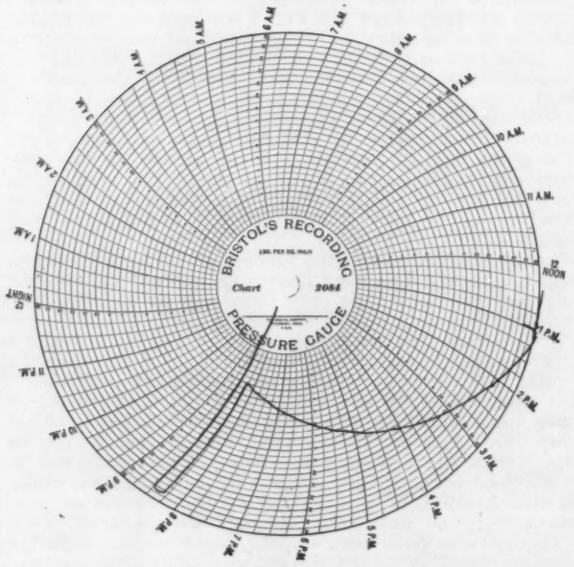

FIG. 5.

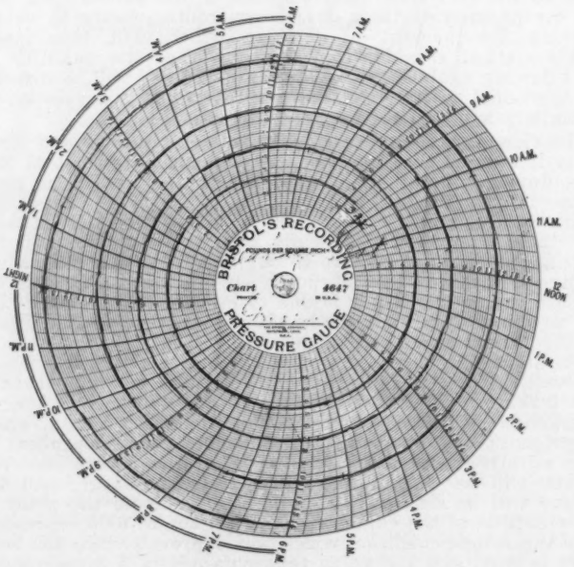

FIG. 6.

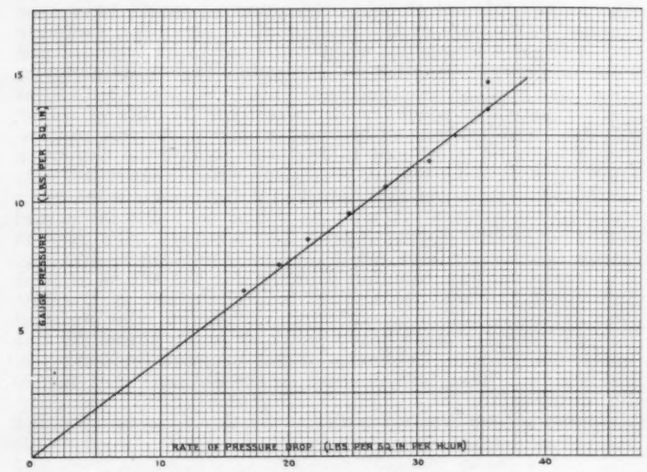

FIG. 7.

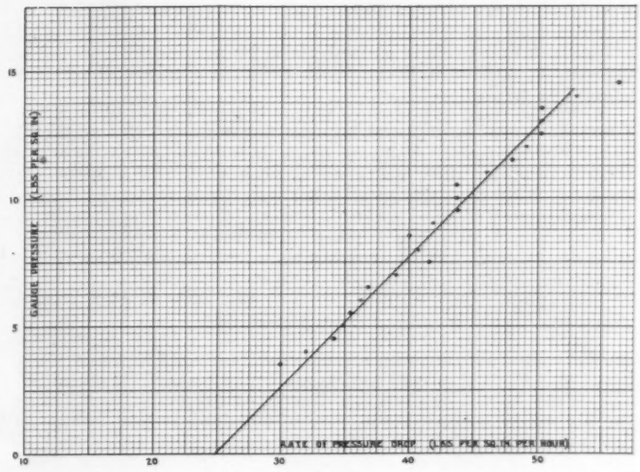

FIG. 8.

the test results, and we are able to locate it within a comparatively small area by successive tests on subdivisions of the major district. The single block and small district tests are used to ascertain the amount of leakage in locations where the presence of a leak is suspected either because of some inconclusive surface indication or because of the age of the installation. They are particularly helpful where the lines are under pavement and actual examination of the pipe would be very expensive. In a number of locations where we have lines that are approaching the age when failures can be expected and where the risk of damage from leakage is greater than normal because of basements extending to the curb line or the presence of underground utility vaults, or similar structures, tests are being made at regular intervals so that any leaks which develop can be detected in the early stages.

The data accumulated from our tests has provided us with a considerable amount of interesting information regarding underground leakage in general and the particular situation in our system. An extended discussion of this material is beyond the scope of this paper, but it may be stated that some of the facts developed were quite at variance with our previous conceptions, and a number of modifications in our leakage elimination program have been made as a result.

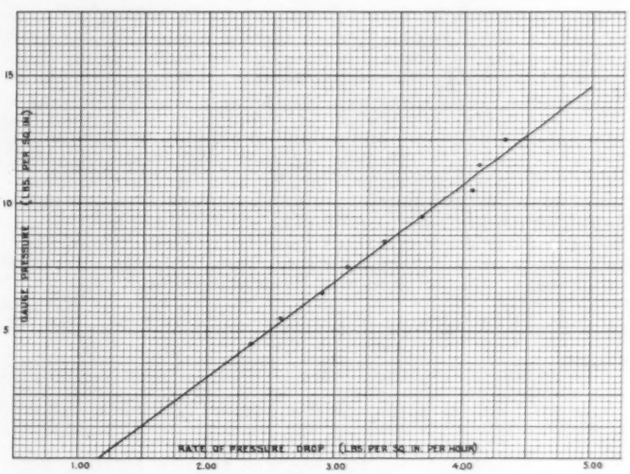

FIG. 9.

The Mechanics of Storage in Natural Gas Transmission Pipe Lines

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OUR knowledge of fluid flow is being constantly broadened and old rule-of-thumb formulae have given way to those based on scientific evidence. In view of this advancement it is strange perhaps that the storage phenomenon in gas lines has received so little study. The most perfect flow formula cannot be applied judiciously nor can a natural gas pipe line be designed economically without some knowledge of pack and draft behavior. All flow formulae employ the concept of continuous conduit flow, and in the case of most natural gas pipe lines, apply to but a few moments of the day. This is always true when line deliveries are non-uniform.

It is quite commonly conceived that line pack is caused deliberately by boosting pressures from head to end of a line and that this stored gas is drafted at will. The first is possible, but generally by accident rather than design; the second is fallacious. Pack does not lend itself to deliberate utilization; it governs its own draft behavior. It cannot be held in a line except at the expense of flow since flow demands pressure drop. With equal daily loads, the daily delivery of a transmission line is never increased because of the pack phenomenon. Under no stretch of the imagination can an accumulation of pack over one or more days be hoarded for a subsequent day. The line would then be used for storage rather than transmission purposes, and a transmission line is a most uneconomical storage holder. However, paradoxically enough pack is an invaluable aid in the utilization of pipe lines.

Reasons for This Study

When designing a pipe line or estimating its adequacy for a coming winter season, some consideration must be given to its peak hour delivery capacity. Studies of existing lines indicate that a morning peak is hurdled with surprising ease, and that a critical capacity condition obtains during an afternoon period instead; consequently, the writer early adopted the practice of basing line tests and design on afternoon peaks. Sometimes even this alternative was suspected of being overly conservative. Curiosity is not confined to the Felis Domestica species alone and soon it seemed imperative to understand pack phenomena which, of course, were behind it all. While a safety factor is conducive to a feeling of security, no one cares to depend upon an intangible one. The question naturally arises: is it always there?

The purpose of this study is to correlate pack phenomena with such variables as pipe diameter, length, friction factor, pressure, and type of load.

The Mechanism of Line Pack

Incident line pack is caused alone by a non-uniform sendout at the end of a line. With uniform sendout there can be no line pack.

When the head pressure of a line is kept constant, and the sendout at the end decreases, the pressure at the end will gradually rise since a lesser drop is required. However the rise in pressure does not keep in step with the decrease in sendout. The rise can be effected only by a storage of compressed gas at the end and this gas must come from the head of the line; it thus contributes to pressure drop as well as does the sendout gas. There are then two distinctly separate inputs at the head of the line: one to meet sendout and one to meet pack. It is significant that the bulk of the packed gas must travel a good length of the line.

As the sendout increases, the end pressure falls. Now there are two separate outputs, the sendout being made up of some input gas from the head and some packed gas from near the end of the line. The pressure drop does not keep in step with the increased sendout since part of the drop is due merely to draft of the compressed gas near the end. It is again significant that the bulk of the drafted gas travels but a short length of the line.

At the time of transition from one flow condition to another there is an instant of continuous conduit flow. During this instant only will the ordinary flow formulae apply.

During periods of heavy packs and drafts a peculiar state of unbalance will exist, usually termed "time lag." At such times pressure changes due to pack or draft are not telegraphed to the ends of the line quickly enough to note simultaneous effects. In other words, the line is not in equilibrium. This secondary phenomenon is probably as good a demonstration in the "fourth dimension" of the theory of relativity as is obtainable in the gas business. The writer does not aspire to such mathematical finesse and the "fourth dimension" of pipe lines must be waived. Throughout this study it will be assumed that equilibrium exists; that is, all effects happen simultaneously from head to end of line. Fortunately, it is only in very long lines that "time lag" produces appreciable effects; these will be explained later.

A Universal Flow Equation

The ordinary flow equation is generally presented as follows:

$$Q = K \sqrt{D^5 (P_1^2 - P_2^2)/f\,LG}$$

where

K = a constant, D = diameter, f = friction factor,
L = length, G = specific gravity, P_1 and P_2 = head and end pressures, respectively, and Q is the rate of flow.

As mentioned before, it applies only at an instant when continuous conduit flow exists. The results of the study presented in this paper show that the following equation gives a close approximation of flow at any instant of the day:

$$\sqrt{.533\,I^2 + .267\,I\,S + .200\,S^2} = K \sqrt{D^5 (P_1^2 - P_2^2)/f\,L\,G}$$

Where I is the rate of input at the head, and S is the rate of output (sendout) at the end of the line. The reader may employ any formula or units he prefers. In other words, the Q in any flow formula is merely replaced by

$$\sqrt{.533\,I^2 + .267\,I\,S + .200\,S^2}$$

the units of I and S being the same as would have been applied in the case of Q. This equation may seem awkward but it is quite convenient when restricted to its intended use.

It is general practice to determine the friction factor or efficiency of an existing line. This is done to predict line performance and adequacy, or to test for deposits of water, oil, dust, and products of internal corrosion. As will be illustrated later, it is difficult to find a period of the day when uniform flow and pressure conditions exist. Sometimes, only an hour a day is suitable for such a test; even when pressures seem constant it may be found that the input and output of a line do not check. The accuracy of a friction factor is seriously impaired if the line is packing or drafting. The universal flow equation provides for the effects of pack and draft and may be applied to any instant of the day. Ordinary precaution should limit its use to the steadiest hours of the day since heavy packs or drafts throw the line out of equilibrium. Otherwise, it has no more limitations in its field than have been imposed on the ordinary flow formulae in the past.

The equation illustrates the point that gas being either packed or drafted must flow in the line as well as does the gas which passes straight through. Consequently, pack and draft gas is subject to the same frictional resistance as straight through gas and contributes to pressure drop as well.

(The derivations of all equations have been omitted from the body of this paper for benefit of continuity and will be found in the appendix).

The most important phase of the transmission line storage phenomenon is its effect on the peak hour sendout of a distribution system. This constitutes the major problem in this work.

Scope of This Study

There must be some limits prescribed in a study of this kind, and the assumptions upon which the theory is based as well as the exact meaning of certain terms should be clear. The following explanations will cover any questions in this regard.

Type of Pipe Line Covered: This study is confined to secondary transmission lines up to 50 miles in length and from four to 30 in. in diameter. The limit on length is necessary since, in longer lines, "time lag" will interfere with the premises. A secondary line is one that is not subjected to a gas dispatcher's control to any great extent but is practically self-operating. All of the gas is assumed to flow from the head to the end of the line.

Operating Pressures: The head pressure is considered constant throughout the day, kept so by hand-control or by automatic regulation. The end pressure is considered to vary because of varying delivery at the end. It is further stipulated that the end pressure must not drop below a prescribed value called the "allowable minimum end pressure." All transmission lines are subjected to this restriction since the distribution areas which they serve require a limiting minimum upstream pressure on the regulators at the entrance to the distribution system.

Type of Line Delivery: The delivery from the end of the line will hereinafter be designated as "sendout," a term commonly used to refer to the gas demanded by a distribution area. Since this study concerns pipe line storage alone, it is assumed that the distribution area does not operate any

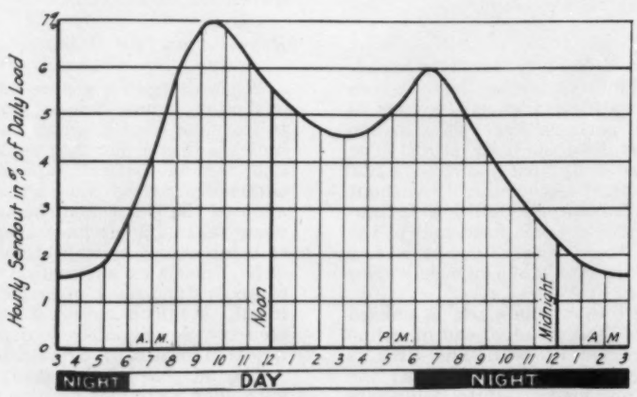


FIG. 1. Typical natural gas area sendout curve.

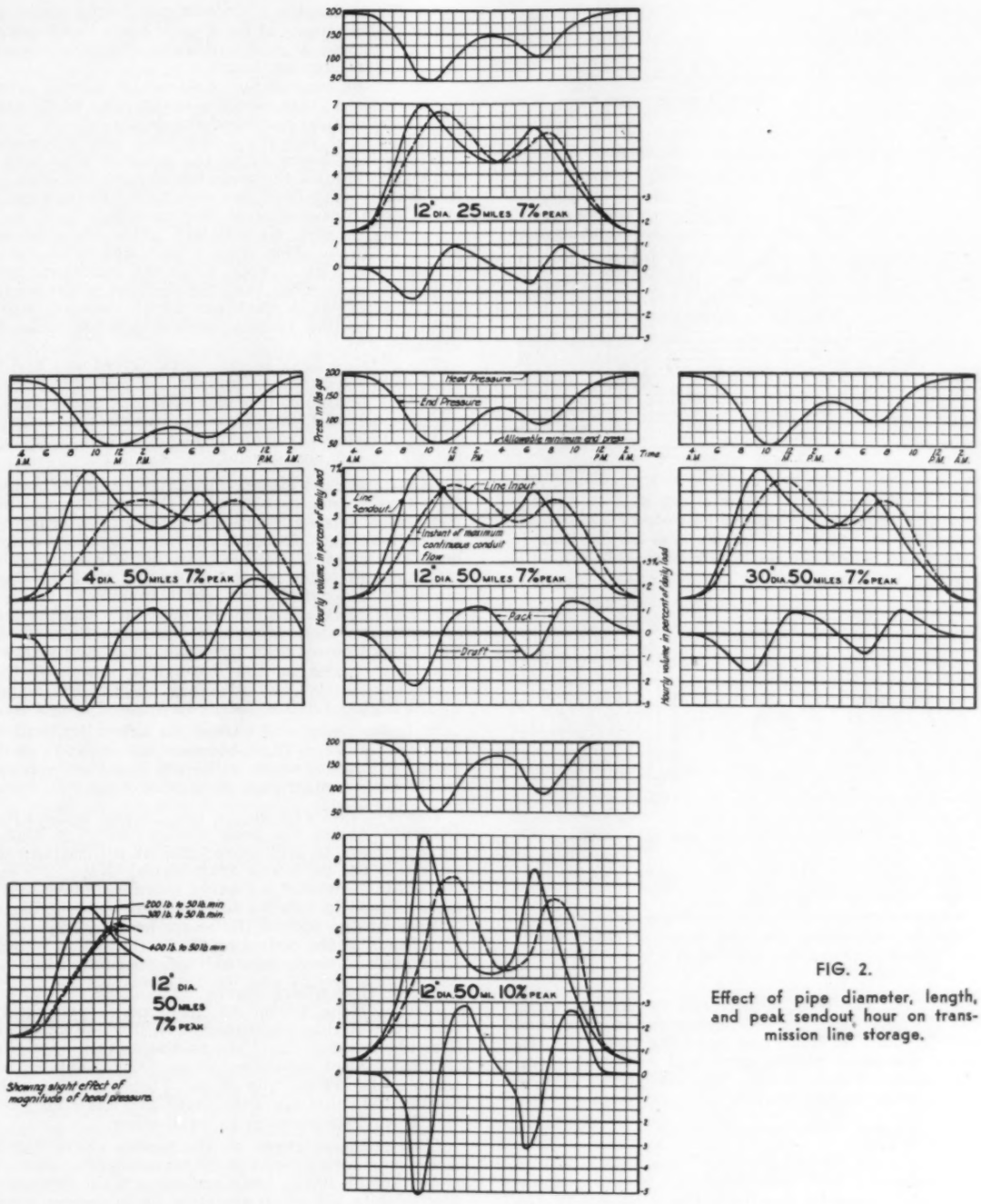

12" DIA. 25 MILES 7% PEAK
Head Pressure
End Pressure
Allowable minimum end press
Press in lbs gas
Time
4" DIA. 50 MILES 7% PEAK
Line Input
Line Sendout
Instant of maximum continuous conduit flow
12" DIA. 50 MILES 7% PEAK
Pack
Draft
30" DIA. 50 MILES 7% PEAK
Hourly volume in percent of daily load
200 lb. to 50 lb. min
300 lb. to 50 lb. min
400 lb. to 50 lb. min
12" DIA.
50 MILES
7% PEAK
Showing slight effect of magnitude of head pressure.
12" DIA. 50 MI. 10% PEAK

FIG. 2.

Effect of pipe diameter, length, and peak sendout hour on transmission line storage.

holders; the line will take care of the sendout at all hours.

Innumerable types of varying sendout are possible if very large industrials are located in distribution areas. These loads are rarely suited to line storage benefits because their peaks are too prolonged. It is assumed that only a moderate industrial load is in effect. The load that reaps the greatest benefit from line pack is that of the typical natural gas distribution area sendout. Such a sendout curve by hours appears in Fig. 1; here the peak hour is seven per cent of the total daily sendout and occurs around the hours of 9 and 10 A. M. This curve is representative of small towns, large cities, and natural gas distribution area in general. Peaks vary in intensity in different localities but the configuration of all curves is surprisingly similar. With normal ambient temperatures the evening peak is always less than that of the morning. This is most fortunate—if the peak hour occurred in the evening, as happens in manufactured gas areas, pipe line pack would be of little benefit. The cause for the reversal of peaks with natural gas can be attributed mainly to heating load.

The first premise of this study which must be justified is the shape of the sendout curves employed. In their defense it may be stated that: first, they are typical of most areas in the Pacific Gas and Electric Co.'s system and, second, anyone at all familiar with the subject can draw a creditable sendout curve knowing but a few governing points. If the per cent sendout and hour are known for morning and evening peaks, and afternoon and night minimums, the curve practically shapes itself since all hourly values must add to 100 per cent and fall on a smooth curve. Moreover, it will be found that the relation between the mentioned control points is surprisingly constant. Human behavior is much the same in all localities.

The solution of cumulative effects requires some starting point in 24-hour behavior. In this work the 24-hour period begins at 3 A. M., the "zero" hour. At this time of minimum

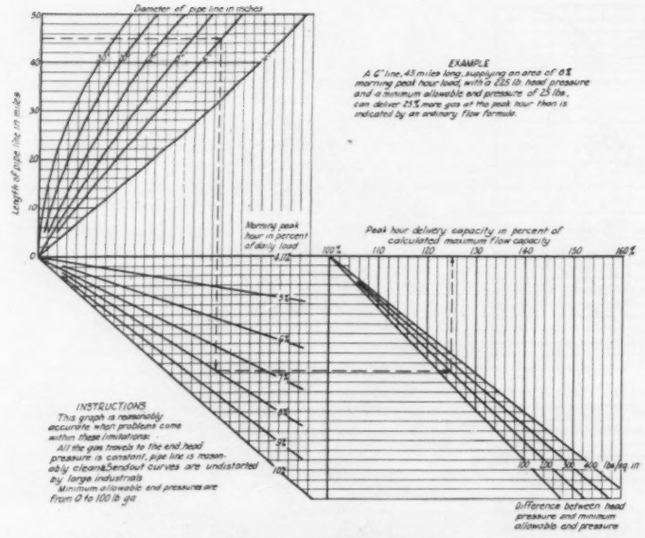

Diameter of pipe line in inches
Length of pipe line in miles
EXAMPLE
Morning peak hour in percent of daily load
Peak hour delivery capacity in percent of calculated maximum flow capacity
INSTRUCTIONS
Difference between head pressure and minimum allowable end pressure

FIG. 3. Chart for determining the effect of line pack on peak hour delivery. (For secondary transmission lines when head pressures are constant and daily loads at the ends of the lines conform to typical natural gas area hourly sendout curves).

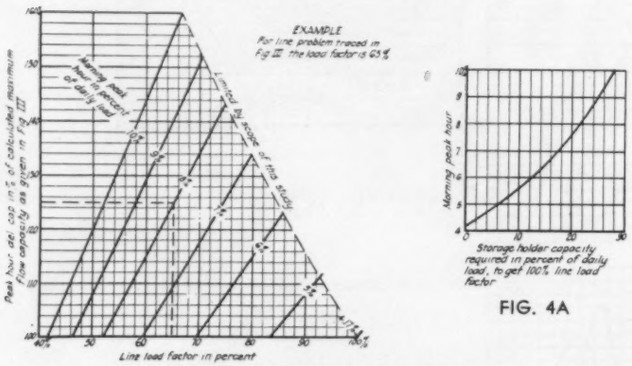


FIG. 4A

FIG. 4. Chart for determining the load factor of pipe lines (used in conjunction with Fig. 3).

sendout neither pack nor draft obtain, and the line contains its maximum storage. One test of each solution was that the line closed its pack at this same hour the next day. In very long lines this does not happen, and constitutes one reason for the scope of this study. The exceptions will be illustrated further on in this paper.

Results of the Study

Various substitutions and manipulations in basic equations have made it possible to attack the problem by the following means:

1. Definite flowing quantities have been avoided and pack, draft, and sendout volumes have been expressed in the indefinite unit of per cent of daily sendout.

2. All equations have been adjusted so as to apply to hourly rather than instantaneous intervals, from which 24 hour line behavior can be deducted.

3. Graphical solutions have been devised (from necessity).

4. Finally, as many combinations of diameter, length, pressure, and sendout have been carried through in actual problems as would definitely fix the effect of each variable, and from these a composite chart was developed.

In Fig. 2 are presented charts, calculated by the developed formulae, to illustrate trends. A study of these charts may lead to some surprising revelations, and calling the reader's attention to a few will not be amiss. In all the charts a constant head pressure of 200 lbs. is assumed as well as a critical allowable minimum pressure of 50 lbs. The remarks follow:

Center Chart (12 in., 50 mi., seven per cent): The draft curve illustrates the statement previously made that packed gas cannot be reserved for a peak hour. Draft begins as early as 3 A. M. and a good portion is practically wasted during low sendout morning hours.

Continuous conduit flow first occurs shortly after 11 A. M. for an instant; this constitutes the peak of this type of flow and is the critical period of the day.

The peak of line input has been retarded more than one and one half hours from the sendout peak and is but 6.1 per cent as against the seven per cent sendout peak. Thus the line is delivering 14.75 per cent more gas than can be handled by its apparent maximum flow capacity.

Packing begins immediately after the critical morning period. The question may arise: why does not the lowest pressure exist at 12 noon when the maximum input occurs? It should be recalled that the sendout is decreasing and the input gas is partly pack gas which does not travel the full length of the line. Consequently, it will not cause the greatest pressure drop.

The evening peak is substantially reduced and is preceded and followed by an instant of continuous conduit flow, neither a maximum however. The line packs very quickly at night, most of it being accomplished long before midnight.

The pressure curve on these charts will naturally represent the storage at any instant.

Right and Left Charts (4 and 30 in. 50 mi., seven percent) Effect of Diameter: Perhaps the most surprising trend is illustrated here—the lines of lesser diameter have the greater pack advantage. A casual canvas of opinions among gas men leads the writer to believe that this is rarely suspected. It is the common tendency to ignore the pack in lines of small diameter. Except for one limitation, very small lines have enormous pack advantages since they possess a lesser flow capacity per unit of cubical contents than do large lines. This is explained, first, by dimensional analysis which shows that flow varies as the five-halves power of the diameter while the cubical contents vary only as the square; second, by the higher friction factor in lines of lesser diameter.

It follows that were there no other limitations, a line of infinite diameter (line becomes an orifice) would have no pack advantage, while a line of diameter approaching zero would have a maximum pack advantage.

Lower Chart (12 in., 50 mi., 10 per cent) Effect of Peak sendout: When the peak sendout hour is high, line pack adapts itself to still more efficient utilization; this is illustrated in the pack and draft curve. Note how much less of the draft is wasted on early morning hours and how much more is held in reserve for the peak sendout period.

Note at the end of the chart how quickly the line packs. This leads to the deduction that, from every standpoint, very high peak sendouts are well adapted to pack benefits.

Lower Left Chart Section (12 in., 50 mi., seven per cent) Effect of Head Pressure: Another surprising discovery in this study is that pressure has so little effect on the problem. The abbreviated chart shows the almost negligible effect of changing head pressures from 200 to 400 lbs. while maintaining the 50 lb. minimum. There was no point in completing the chart since the input and draft curves were practically superimposed upon each other.

The pressure curve of the center chart (12 in., 50 mi., seven per cent) could well represent the end pressure for either 300 or 400 lb. head pressures if the pressure scale were divided into 300 to 50 or 400 to 50 lb. intervals, respectively. The relative unimportance of head pressure is an invaluable aid in the simplification of this work.

Chart for Determining the Effect of Line Pack on Peak Hour Delivery

However interesting trends may be they solve no problems. Therefore, a chart, Fig. 3, is presented in which all variables are included and which permits a quick solution to any line problem within the scope of this study. The preparation of this chart required the calculation of a great number of individual problems. It was gratifying, indeed, to find that the data were at all suited to graphical representation. Space does not permit illustrating the coordination of data employed. In a certain sense the many solutions were in the same category as experimental data. This can be expected since the basic sendout curve conforms to no known algebraic function of time. To those whose ethics demand verification of chart accuracy before adoption, it is suggested that a problem or two be checked beginning with the basic equations. The chart itself offers a much more direct approach in

a check than was available in its cut-and-try construction.

Solutions in Fig. 3 are given in terms of "peak hour delivery capacity in per cent of maximum flow capacity." In effect, this is an expression of the ratio of the peak sendout hour volume to the maximum continuous conduit flow volume. It is felt that this is the most useful presentation. The procedure used in the construction of the graph was as follows:

Consider a six-in. line 45 miles long, meeting an eight per cent sendout peak, with head pressure of 225 lbs. and minimum allowable end pressure of 25 lbs. If a 24-hour draft curve were developed by means of the formulae in the Appendix, it would be found that the instant of maximum continuous conduit flow occurred at a point where the sendout was 6.4 per cent. The line would then deliver 100 (8.0/6.4) or 125 per cent of its apparent maximum hourly delivery capacity, which, of course, would be its capacity at 225 lbs. head and 25 lbs. end pressure. This particular solution is traced on Fig. 3. The use of this chart in a practical problem will best illustrate the procedure to be employed.

Suppose gas service is to be extended to a new area 45 miles distant from a source of natural gas. Depending on permissible investment, possibility of new ties from other natural gas sources, etc., the life of the line as sole supply is fixed at a certain number of years. A survey of prospective customers and ultimate growth indicates that, at the expiration of this time, the winter peak day demand will be about 2600 M c.f. per day. Experience has shown that similar areas develop winter peak hours of eight per cent of the total daily demand. (Based on firm or domestic use since surplus sales gas is generally curtailed on winter peaks). On these bases it can be expected that a peak hour of (.08) (2,600) or 208 M c.f. will ultimately exist. It is expected that a head pressure of 225 lbs. will be available and that 25 lbs. or more will satisfy the distribution regulator's requirements. What diameter of line will meet the load?

Although the writer does not employ Weymouth's formulae in practice, it will be used for this example. Assuming that Weymouth's friction factor applies in this case, calculation shows that the maximum flow capacity of a 6 in. line (f = .0044) is about 166 M c.f. per hour which might easily influence the choice of an 8 in. line. From Fig. 3, however, the peak hour delivery of this line is actually (166) (1.25) or about 208 M c.f. per hour which meets the requirements. A more direct procedure is, of course, to divide 208 by 1.25 giving the value of 166 M c.f. per hour to introduce into the flow equation.

What Is the Ultimate Benefit of Transmission Line Storage?

There is danger that peak hour benefits from transmission line storage might be misinterpreted. The 25 per cent excess delivery in the foregoing example should not be confused with a daily increase. Continuation of this problem might be of some help in avoiding this misinterpretation.

Obviously 208 and 166 M c.f. are eight and 6.4 per cent, respectively, of the same daily load, namely 2,600 M c.f. The daily delivery has not been increased one iota because of line storage. The only benefit has been a smoothing out of the curve representing line input and to hurdle a high peak hour.

It should be fairly evident then that transmission line storage cannot be compared with a gas holder in any way. A gas holder can be used to increase the daily delivery of a line, something transmission line storage cannot do. This can be illustrated in the given problem.

Suppose a low pressure storage holder is built in the distribution area. Let it be large enough to take up the hourly sendout variation so that the line might be constantly operated at the minimum end pressure of 25 lbs. The line input curve will then be a horizontal line at a value of 100/24 or 4.17 per cent; no curvature will exist. The continuous conduit flow capacity would then give (24) (166) or almost 4,000 M c.f. per day as compared with the former delivery of 2,600 M c.f. per day, an increase of almost 54 per cent. Perhaps one should reiterate that line storage and a storage holder are not comparable.

Load Factor of Transmission Lines

In view of the results in the example given above, it should be interesting to know the load factor for various lines and sendout curves. In other words, how much do we lose because of non-uniform sendout demands. This is comparatively simple since the values from Fig. 3 lend themselves to this transformation.

Let

V = daily delivery or sendout in cubic feet.

s_c = sendout at the critical instant of continuous conduit flow when the minimum allowable end pressure exists, expressed as per cent of V.

Q = maximum continuous conduit flow capacity of the line at the time when s_c occurs.

s_x = peak sendout hour expressed as per cent of V.

F = factor picked from Fig. 3.

Then $V = 100\ Q/s_c$

but it will be recalled that $F = 100\ s_x/s_c$

thus $V = F\ Q/s_x$

Dividing this by the daily delivery of a line operating at uniform flow, which is of course equal to 24 Q, will give the load factor of the line of non-uniform delivery. Thus

Per cent Load Factor $= 100\ F/24s_x$

Load factors are plotted in Fig. 4. As a matter of interest the required holder capacity for 100 per cent line load factor is also plotted.

Lines of Non-Uniform Diameter

It may occur that a transmission line is made up of lengths of pipe of different diameters. Such a problem can be adapted to the charts in this paper very easily. The principle involved is as follows:

Convert the line to an equivalent line of some uniform diameter and some length so that,

First: It will produce the same flow for the same pressure drop as the original line.

Second: Its cubical contents are the same as the original line.

Analysis will show that the diameter of such a line is:

$$D_e = \sqrt[7]{\frac{f_e\,(D_1^2 L_1 + D_2^2\ L_2 + \ldots.)}{\left(\frac{f_1 L_1}{D_1^5} + \frac{f_2 L_2}{D_2^5} + \ldots.\right)}}$$

and the length is $L_e = (D_1^2 L_1 + D_2^2 L_2 + \ldots.)/D_e^2$

The subscripts 1, 2, etc., refer to the sections of line of unequal diameter and (e) refers to the equivalent line. D, L, and (f) are diameter, length, and friction factor, respectively.

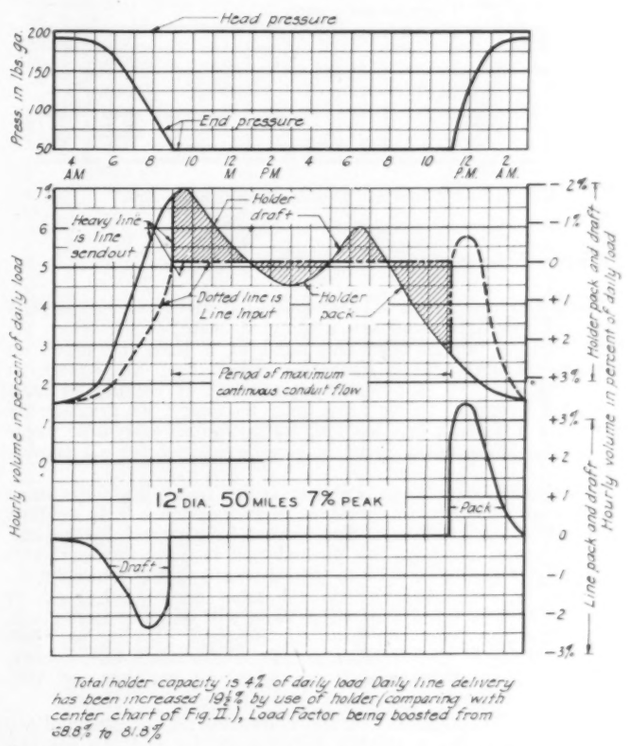


FIG. 5. Effect of a storage holder on line storage and daily delivery.

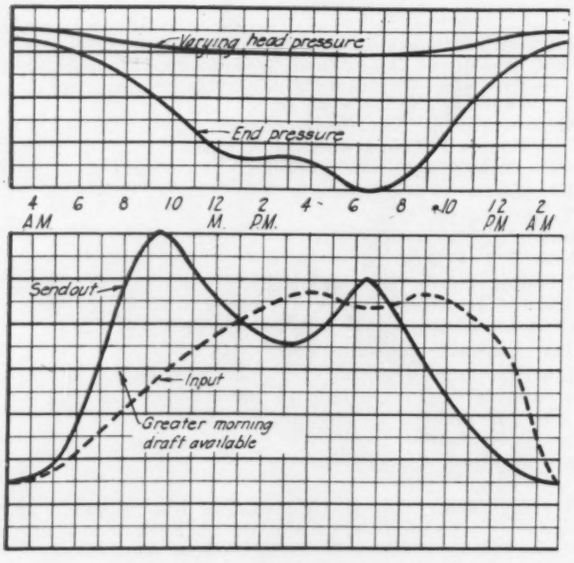


FIG. 6. Effect of varying head pressure on line storage.

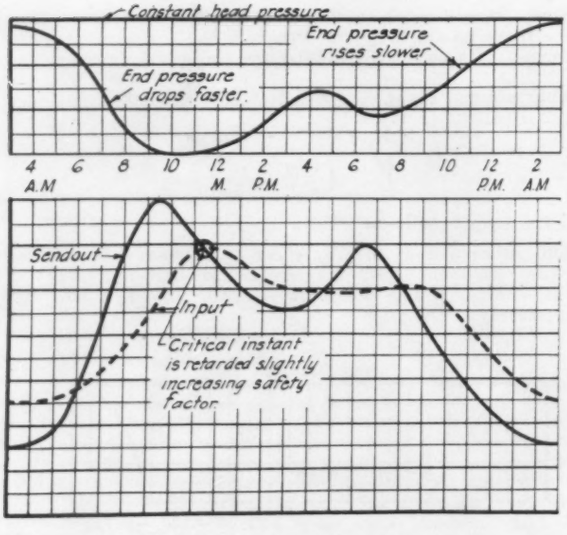

Constant head pressure
End pressure rises slower
End pressure drops faster.
4 6 8 10 12 2 4 6 8 10 12 2
A.M. M. P.M. P.M. A.M.
Sendout
Input
Critical instant is retarded slightly increasing safety factor

FIG. 7. Effect of "time lag" on line storage.

Effect of Intermediate Line Deliveries

Very infrequently is all gas delivered at the end of a pipe line. Intermediate taps are a general occurrence. When an intermediate tap is near the head of a line, its effect on storage is small; when near the end, it may be thrown in with the end tap. Obviously, a variety of conditions may exist with respect to its peak hour intensity, its fraction of the total line load, its location, its minimum allowable pressure, etc. No general formula can be offered for all combinations.

Usually the end tap is the critical tap in all problems since the lowest pressure is found at that location. It is evident that all of the pack in a line cannot be credited to the end tap, although most of the packed gas is near the end, and none of it flows backward to intermediate taps. While intermediate taps are thereby denied some pack advantage, it must be kept in mind that these taps will demand that much more flow gas from the head of the line. Having weighed all effects, it is the opinion of the writer that the easiest, safest, and most reasonable procedure in problems of this kind is as follows:

Taking into consideration the deliveries at all intermediate taps, calculate the available delivery at the end tap for the minimum allowable end pressure. Apply the charts to this end delivery as if it were the entire output from the line.

Combination of Storage Holder and Line Storage

Combinations of storage holders with line storage opens up another field of study. This concerns combinations in which the storage holder has less capacity than would be required to realize a 100 per cent load factor. Any such problem could be solved by the procedure outlined in the appendix. The only difference would be in the deformed sendout curve due to holder assistance. The morning and afternoon sendout peaks would then be partially decapitated, resulting in plateaus. An endless series can be built up on this study. It is felt that such special solutions had best be left to the industry of the reader should they be necessary. The trend of such a combination is shown in Fig. 5 and since the results are rather surprising one should pause a moment and study the effect.

Consider the 12 in., 50 mile line (center chart) of Fig. 2. Without a storage holder, this line has a load factor of 68.8 per cent as can be determined from Figs. 3 and 4. If a storage holder, having a capacity equal to 17.5 per cent of the daily load, were available the line could operate at a load factor of 100 per cent. (From Fig. 4a) However, the really surprising fact is that with only four per cent holder capacity, the line's load factor can be raised to 81.8 per cent. In other words, the addition of a small holder of four per cent capacity increases the daily line delivery by 19.5 per cent. This can be seen in Fig. 5 where the load factor is equal to (100)(4.17)/(5.1) or 81.8 per cent. It has been assumed that this line and holder have been perfectly operated. The rules of perfect operation can be stated as follows:

Allow the end pressure to drop to the minimum allowable pressure in the morning before touching the holder. Too often the tendency is to save a little line pack for a so-called emergency. This is pure fallacy since to get the most out of the line, its minimum end pressure should obtain for the longest possible period during the day. Comparison of the figures shows this—instead of the one instant of maximum continuous conduit flow in Fig. 2, there is a period of 14 hours in Fig. 5.

Do not build line pack in the mid-afternoon; let the holder fill instead, for the same reason as above. This small storage may save the day.

Fill the holder in the evening before ever allowing the line to pack, again for the same reason. If this rule is not religiously observed either the holder, the line, or both will fail to complete their pack by 3 A. M. in the morning.

In this illustration so little holder capacity has done so much good that, in the case of many existing overloaded lines, a study in the economics of such combinations would seem astute.

Effect of Varying Head Pressure

It happens often that the head pressure on a secondary transmission line is not constant. Usually this is due to the absence of a regulator at the junction with the main transmission line, or to deliberate periodic regulator by-passing when the lines are heavily pressed. In such cases the varying pressure of the main transmission line, due to its non-uniform load, are reflected in the secondary line. The premises based on such characteristics are so varied and indefinite that no simple presentation can be made. Again, it is possible to adapt the procedure herein for such a solution; the labor involved is considerably greater, however.

The trend of such a condition is shown in Fig. 6. The critical flow period, when the end pressure is lowest, is postponed to the late afternoon and is attached to the evening peak. The average head pressure could be used with safety for the charts shown herein.

Effect of "Time Lag"

The effect of "time lag" is shown in Fig. 7. This characteristic curve will be recognized immediately by those who are familiar with transmission line behavior. This effect is particularly noticeable in very long lines and is present to some degree in all lines. As with Figs. 5 and 6 this figure should be compared with the center chart of Fig. 2.

If a line were of infinite length "time lag" would permit a typical sendout curve to be satisfied with a constant line input at 4.17 per cent. For this reason the scope of this study was limited to lines of 50 miles in length. Although "time lag" affects 50-mile lines to some degree, one point

should be mentioned. This study is concerned primarily with the instant of maximum continuous conduit flow. This occurs at the end of the major draft period. The bulk of the draft gas is at the end of line, at the very doors of the distribution area. It need not travel very far, and consequently, is not affected by "time lag" as much as might be suspected. Examination of all of the curves will show that if the pack closure were to occur, not at 3 A. M., but at 4, 5 or perhaps even 6 A. M., the critical instant would not be retarded greatly. Nothing much happens in the matter of draft during these hours.

An important point to realize is that "time lag" contributes to the safety factor in pipe line delivery. Its exclusion in this treatise has done no harm. The working charts are still on the conservative side.

Conclusion

An attempt has been made to analyze the mechanics of pipe line storage. While the study is not the complete answer to the problem, it is a step in that direction. Few engineering practices are founded on a background of absolute scientific fact. With most complex subjects one must be satisfied to analyze only such variables as can be comprehended and provide for the others by judgment or experience. Without this initial concession no phenomenon is even partly understood and no progress is made.

The purpose of this study was to evaluate the rather intangible safety factor which exists in pipe line delivery. This has been done to a considerable extent. A portion of the factor still remains intangible due to "time lag." The important point is that this portion does remain. Consequently, no unsafe practice will result from the use of any of the data contained in this paper.

It is hoped that this attempt to express the principles of non-continuous conduit flow will succeed in bringing about a better understanding of transmission line storage, and that it may be of practical use to the gas industry, and that it will stimulate enough interest in the subject to urge others to continue its development.

The writer wishes to acknowledge the many helpful suggestions by Mr. Frank Wills toward a clearer presentation of the subject, and the assistance of Mr. E. G. Arnedt in calculations and checking.

The appendix following contains the mathematical development of transmission line storage. It provides the foundation for this study and the practical working charts.

APPENDIX

Derivation of pack and Draft Equations With an Example of Their Application

Consider a transmission line of length L, in feet, and cross sectional area A, in square feet. The gas contained within the pipe is ALP_a/p where P_a is the average absolute pressure in the line and p is the base pressure (30 in. Hg.). For a drop in average pressure over any period of time, the draft gas Q_d, in cubic feet, is equal to

$$Q_d = AL\ (P_a \text{ drop})/p \qquad (1)$$

If the pressure P_1 at the head of the line remains unchanged and the end pressure P_2 varies from P_b at the beginning of an hour to P_e at the end of the hour:

$$Q_d = AL\ (P_b - P_e)/2p = AL\ P_d/2p \qquad (2)$$

wherein P_d is the drop in pressure P_2 at the end of the line in one hour.

If the pressure at the end of the line varies from a maximum, P_m (at minimum flow during the night) to a critical allowable minimum, P_c (at heavy flow during the day), the total available pack in the line from (2) is equal to

$$AL\ (P_m - P_c)/2p \qquad (3)$$

The straight through flow of the line can be written

$$Q = 181.6\ \sqrt{D^5\ (P_1^2 - P_2^2)/fLG} \qquad (4)$$

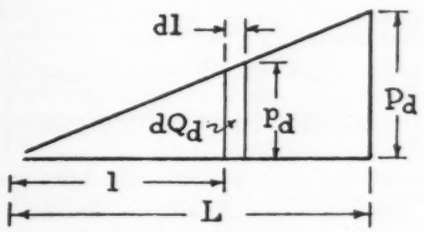
wherein Q = cu. ft. per hour, D = diam. in inches, f = friction factor, and G = specific gravity.

For convenience let $C = 181.6\ \sqrt{D^5/fG}$ (5)

then $Q^2 = C^2/L\ (P_1^2 - P_2^2)$ (6)

In this study Q is made up of the conventional flow gas Q_f, which enters the line at its head and travels to the end, and of draft gas Q_d, the most of which travels but a fraction of the length of the line. The first step is to evaluate Q in terms of its two components.

Let a triangle represent the gas drafted from pack during one hour, its apex being at the head of the line and its base of dimension P_d being at the end. (See Note 1 at end of appendix.)



From (1) the draft dQ_d in the differential length dl is equal to

$$dQ_d = A\ dl\ p_d/p$$

but

$$p_d = P_d l/L \text{ whence } dQ_d = AP_d\ l\ dl/pL$$

The gas flowing in any section dl is made up of the flow coming in at the head Q_f plus the summation of dQ_d from the head to point l. Thus

$$Q \text{ (at point l)} = Q_f + \int AP_d\ l\ dl/pL$$
$$= Q_f + AP_d\ l^2/2pL$$

From (6)

$$P_l^2 - P^2{}_{l+dl} = Q^2\ dl/C^2$$

and letting $AP_d/2p = M$ for convenience, the pressure square drop in any length dl is equal to

$$\frac{1}{C^2}\left[Q_f^2 + 2\ Q_f\ Ml^2/L + M^2l^4/L^2\right] dl$$

The summation of all pressure square drops from O to L is $P_1^2 - P_2^2$ so that (see Note 2 at end of appendix):

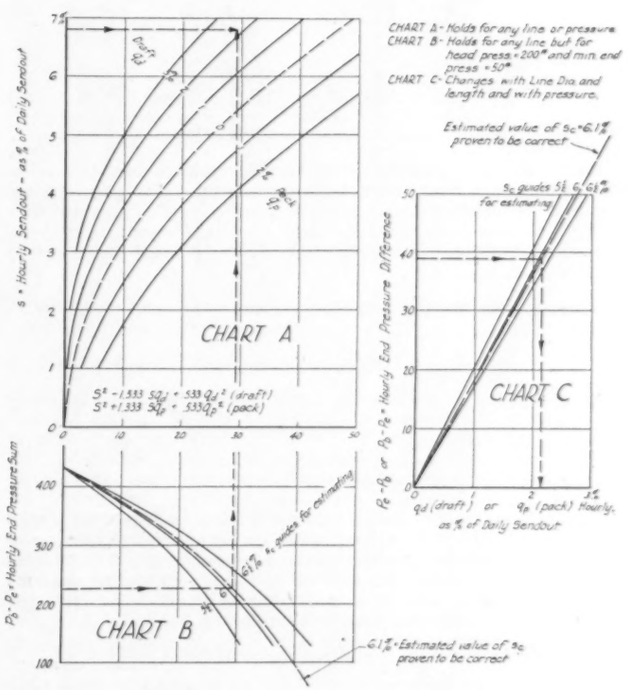


CHART A
CHART B
CHART C
CHART A- Holds for any line or pressure.
CHART B- Holds for any line, but for head press.=200# and min. end press.=50#.
CHART C- Changes with Line Dia. and length and with pressure.
Estimated value of sc=61%
proven to be correct
sc guides 58 & 61% for estimating
61% sc guides for estimating
61% = Estimated value of sc proven to be correct
s = Hourly Sendout - as % of Daily Sendout
Pb² - Pe² = Hourly End Pressure Sum
Pb - Pe or Pb² - Pe² = Hourly End Pressure Difference
qd (draft) or qp (pack) Hourly, as % of Daily Sendout

FIG. 8. Graphical method used in solving pack and draft equations (for sample problem given in appendix).

$$P_1^2 - P_2^2 = \frac{1}{C^2}\int \left[Q_f^2 + 2\,Q_f\,Ml^2/L + M^2l^4/L^2\right] dl$$

Integrating between the limits of O and L

$$P_1^2 - P_2^2 = \frac{L}{C^2}\left[Q_f^2 + 2\,Q_f\,ML/3 + M^2L^2/5\right]$$

Substituting the value for M in (2)

$Q_d = ML$ thus

$$P_1^2 - P_2^2 = \frac{L}{C^2}\left[Q_f^2 + 2\,Q_f\,Q_d/3 + Q_d^2/5\right] \quad (7)$$

It is desirable to avoid the definite flowing quantities in (7) and adapt all data to per cent sendout curves.

Let V = total daily sendout and S = hourly sendout, in cubic feet. Let s, q_d, and q_f represent hourly sendout, draft flow, and straight through line flow respectively, all as an hourly percentage of the total daily sendout. Then

$$S = sV/100,\ Q_d = q_d\,V/100 \text{ and } Q_f = q_f\,V/100 \quad (8)$$

Since $S = Q_f + Q_d$

$$Q_f = V(s - q_d)/100 \quad (9)$$

Substituting in (7) from (8) and (9)

$$P_1^2 - P_2^2 = \frac{L}{C_2}\left(\frac{V}{100}\right)^2\left[s^2 - 1.333\,sq_d + .533\,q_d^2\right] \quad (10)$$

But flow during any hour is dependent upon P_1 and the average pressure at the end of the line for the hour, that is $P_2 = (P_b + P_e)/2$

Equation (10) can then be written

$$s^2 - 1.333\,sq_d + .533\,q_d^2 = \frac{P_1^2 - (P_b + P_e)^2/4}{\left(\frac{V}{100}\right)^2\frac{L}{C^2}} \quad (11)$$

The critical minimum allowable pressure, P_e, obviously, will exist at the time that q_d is zero, and, if s_c represents the hourly sendout at this time, as the per cent of the total daily sendout,

$$\left(\frac{V}{100}\right)^2 = (P_1^2 - P_e^2)C^2/s_c^2L \quad (12)$$

Substituting in (11)

$$s^2 - 1.333\,sq_d + .533\,q_d^2 = \frac{s_c^2\,[P_1^2 - (P_b + P_e)^2/4]}{P_1^2 - P_e^2} \quad (13)$$

Equation (13) now satisfies the flow characteristics of a line during one hour while both input and draft gas is flowing and represents the adaptation of equation (4) to this study. It now becomes necessary to adapt equation (2) in a similar fashion since both (2) and (4) must be satisfied during each hour.

Substituting in (2) for Q_d (from (8)) and for V/100 (from (12))

$$q_d = s_c\,AL^{3/2}(P_b - P_e)/2pC\sqrt{P_1^2 - P_e^2} \quad (14)$$

and substituting for C (from (5)) and for $A = \pi D^2/144 \times 4$

$$q_d = \frac{s_c\,L^{3/2}}{980{,}890}\sqrt{\frac{f\,G}{D\,(P_1^2 - P_e^2)}}\,(P_b - P_e) \quad (15)$$

One other relation must be established in order to apply equations (13) and (15), namely the starting point of pressure P_2 and designated herein as P_m, being the maximum pressure existing at the end of the line when the sendout equals the input and is a minimum (say at 3 A. M.), the draft is zero, and the line is completely packed.

If s_o represents this minimum sendout then from (11)

$$P_m^2 = P_1^2 - s_o^2\,\frac{L}{C^2}\left(\frac{V}{100}\right)^2 \quad (16)$$

A legitimate approximation can be used to eliminate the term V. If s_x be the peak hour of any sendout curve, then an approximation for s_c may be taken as $(6/7)s_x$. (This will be verified later.) Substituting in (12),

$$\text{then}\left(\frac{V}{100}\right)^2 = (P_1^2 - P_e^2)\,C^2/(6/7)^2\,s_x^2L \quad (17)$$

Substituting in (16)

$$P_m = \sqrt{P_1^2 - 1.36\,(P_1^2 - P_e^2)\,s_o^2/s_x^2} \quad (18)$$

A practical problem will best illustrate the use of formulae (13), (15) and (18).

Consider a pipe line 12 in. in diameter and 50 miles long supplying a distribution area conforming to a 7 per cent sendout curve, the minimum allowable end pressure being 50 lbs. gage and the constant pressure at its head being 200 lbs. gage. Plot pack and draft hourly.

$P_1 = 214.73$ lbs. abs.	$s_m = 1.5$ per cent
$P_e = 64.73$ lbs. abs.	$P_1^2 = 46109$
$L = 50 \times 5280 = 264{,}000$ feet	$P_e^2 = 4190$
$D = 12$ in. $\quad G = .60$	$L^3/^2 = 135{,}600{,}000$
$s_x = 7$ per cent	$f = .0035$ (see Note 3)

The starting pressure at 3 a.m. from (18) is

$P_m = \sqrt{46109 - 1.36\ (46109 - 4190)\ (1.5/7.0)^2}$

$P_m = 208.5$ lbs. abs.

At this point it is of interest to justify the approximation of s_c as 6/7 of s_x. Had this value been taken as 5.5/7 or 6.5/7 of s_x, P_m would have been 207.5 and 209.5 lbs., respectively. Preliminary trials avoided such poor judgment and limited this probable error to less than a quarter of a pound in either direction. However, even the two lb. band affects the results very slightly.

Equation (13) is reducing to the following:

$$s^2 - 1.333\,sq_d + .533\,q_d^2 = \frac{s_c^2\,[46{,}109 - (P_b + P_e)^2/4]}{46{,}109 - 4190}$$

$$= (5.964)\ (10^{-6})\ s_c^2\,[184{,}436 - (P_b + P_e)^2$$

and is plotted in Fig. 8, chart A-B. Ignore for the moment the curves labeled as q_p.

Equation (15) is reduced to the following:

$$q_d = \frac{s_c\ 135{,}600{,}000}{980{,}890}\sqrt{\frac{.0035 \times .6}{12\ (46{,}109 - 4190)}}\ (P_b - P_e)$$

$$= .008932\ s_c\ (P_b - P_e)$$

and is plotted in Fig. 8, Chart C.

A tabulation is now begun in which equations (13) and (15) are applied to each hour beginning at 3 a.m. The starting pressure is the value for P_m of 208.5 lbs. A value for s_c must be chosen and the hourly values calculated until pack is exhausted, at which time P_e must closely approach 50 lbs. gage or roughly 65 lbs. abs. If the chosen value does not achieve this result, new values of s_c must be tried until this condition is effected. In this example, by trial, a value of $s_c = 6.1$ was finally found to satisfy the requirements. It should be understood that it is the value of s_c which is really sought and, as such, it must be more accurately determined than was the approximation of s_c employed in determining P_m.

A working curve for $s_c = 6.1$ is sketched in on Charts B and C (Fig. 8) in the proper position and the tabulation follows. Obviously the formulae could have been made to apply to intervals less than one hour; it is felt that an attempt for such extreme accuracy is unwarranted. The calculations are tabulated in Table No. 1.

The procedure is as follows: Assume that the calculation for the hour 8 a.m. has been completed. A drop of 39 lbs. is tried lowering P_2 from 133.5 to 94.5 lbs. On Chart C this drop indicates that $q_d = 2.14$ per cent. The sum of the pressures is 228 lbs. which with s equal to 6.8 per cent gives in Chart A-B the same value of $q_d = 2.14$ per cent. Thus step (9 A. M.) has been checked and is completed. This process is continued until the draft is zero and the pressure is 65 lbs. From this point on pack equations must be applied in which there are only two differences: First, equation (13) becomes

TABLE NO. I. APPLICATION OF EQUATIONS (13) AND (15).

Hour	Sendout s	End Press P_2	Press. Diff. (P_b-P_e)	Press. Sum (P_b+P_e)	Draft q_d
3 A.M.	1.5%	208.5			
			1	416	
4	1.6	207.5			.05
			2	413	
5	1.8	205.5			.10
			13	398	
6	2.8	192.5			.75
			22	363	
7	4.2	170.5			1.20
			37	304	
8	5.8	133.5			2.03
			39	228	
9	6.8	94.5			2.14
			26	163	
10	6.8	68.5			1.42
			3.5	133.5	
11	6.2	65.0			.20

$$s^2 + 1.333\ sq_p + .533q_p^2 = \frac{s_c^2\,[P_1^2 - (P_b + P_e)^2/4]}{P_1^2 - P_e^2} \qquad (19)$$

the (+) sign having replaced the (—) sign in the second term on the left, and q_p (per cent pack) having replaced q_d; second, equation (15) becomes

$$q_p = \frac{s_c\, L^{3/2}}{980,890}\sqrt{\frac{f\,G}{D\,(P_1^2 - P_e^2)}}\,(P_e - P_b) \qquad (20)$$

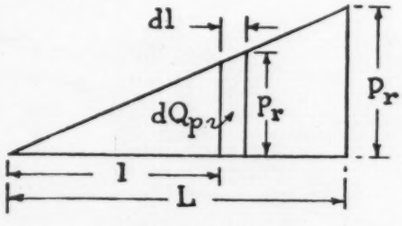
q_p having replaced q_d and the signs of $(P_b - P_e)$ having been reversed.

The tabulation is therefore continued in the same manner employing the q_p curves in Chart A-B and using Chart C as it stands except that the end pressure is subtracted from the beginning pressure in the tabulation. In the course of 24 hours one more series of draft and pack calculations is necessary. This problem is plotted in completed form in the center chart of Fig. 2.

One point should be brought out here: The cut and try procedure is used for only the minimum pressure hour. When this has been achieved the rest of the tabulation is clear sailing.

The derivation of equations (19) and (20) will be omitted. For those who desire verification the following premises are noted:

Let P_r represent the rise in pressure at the end of the line, then as before



$$dQ_p = A\,dl\ p_r/p$$

but $$p_r = P_r\,l/L$$

whence $$dQ_r = A\,P_r\,l\,dl/p\,L$$

The gas flowing in any section dl is the flow going out at the end (S = sendout) plus the summation of dQ_p from l to L. Thus

$$Q\ (\text{at point l}) = S + \int_l^L A\,P_r\,l\,dl/\,p\,L$$

$$= \frac{S + A\,P_r\,L}{2\,p} - \frac{A\,P_r\,l^2}{2\,p\,L}$$

Squaring, integrating pressure square drops from O to L, and making substitutions as done previously results in equations (19) and (20).

The equations for both draft and pack flow in this derivation reduce to a common equation when line input and line output alone are considered.

In the derivation it was necessary, for clarity, to carry through certain identities in the matter of pack and draft. If Q_r be generally expressed as line input then equation (7) may be rewritten.

Let

I = line input (formerly identified as Q_r in the draft derivation) in cu. ft. per hr.

S = line output or sendout (as before) in cu. ft. per hr.

Then, since $S = Q_d + I$

$$\text{and } C = 181.6\,\sqrt{D^5/f\,G} \qquad \text{(from 5)}$$

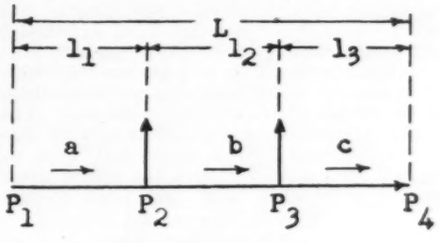
Equation (7) may be rewritten as follows:

$$\sqrt{.533\,I^2 + .267\,I\,S + .200\,S^2} = 181.6\,\sqrt{D^5\,(P_1^2 - P_2^2)/f\,LG} \qquad (21)$$

Formula (21) is a universal flow formula which applies to any instant of the day whether the line is packing or drafting or when neither takes place. It is, of course, based upon a line that is in equilibrium. In equation (21) as in equation (4), D = diameter in inches, f = friction factor, G = specific gravity, L = length in ft., and P = pressure in lbs. per sq. in. absolute.

Note 1: The reader may justly question the validity of the straight line variation of draft. Unquestionably this is not absolutely accurate since the pressure drop in a line does not vary in a linear fashion. Some hopes were originally entertained during this work of including actual pressure variation, but the complexity involved was too great an obstacle. It is obvious that the curve of pressure variation is constantly changing every moment of the day. Suffice it to say that the effect, as estimated, is relatively small and in the face of the omission of time lag in this investigation is reasonably ignored.

Note 2: The summation of pressure square drops may be questioned when a summation of pressure drops is known to be true arithmetically. The procedure is more mathematical than physical. For example: Consider a line of length L having two intermediate taps as well as one end tap. Let the three taps occasion flowing quantities and pressures as indicated in the diagram. For simplicity let X be a constant representing the formula constant together with D, f, and G.



Then

$$P_1^2 - P_2^2 = X\,a^2 l_1$$
$$P_2^2 - P_3^2 = X\,b^2 l_2$$
$$P_3^2 - P_4^2 = X\,c^2 l_3$$

Adding $$P_1^2 - P_4^2 = X\,(a^2 l_1 + b^2 l_2 + c^2 l_3)$$

Multiplying and dividing by L

$$P_1^2 - P_4^2 = X\,[a^2 l_1/L + b^2 l_2/L + c^2 l_3/L]\,L$$

If arithmetical substitutions should be made within the bracket and the square root taken, a value would result which is known as the "through flow." It is the flow from end to end which will effect the same pressure drop as the unequal flows in the sections. Obviously, the actual densities existing in the various sections have been replaced by an average density over the entire length. Unless this transformation is understood the procedure will seem in error.

Note 3: The friction factors used in this work are the result of the experience of the Pacific Gas and Electric Co. supported by the conclusions of Johnson and Berwald as reported in the Bureau of Mines Bulletin No. 2942. The premises of this paper involve maximum deliveries mainly, and consequently, high Reynolds Numbers obtain. For pipe diameters of 12 to 30 in. inclusive the value of f = .0035 has been used. From 12 to 4 in. the values have been graded from .0035 to .0040 in cognizance of the wall roughness effect.

The Effect of Dehydration On Natural Gas Transmission

By J. V. COWAN

El Paso Natural Gas Company

THE partial dehydration of natural gas entering the El Paso Natural Gas Co.'s system has entirely eliminated former problems of "freezeups" and low line transmission efficiencies.

Most of the Company's main line transverses the southern portions of New Mexico and Arizona. This region has large daily and seasonal temperature variations. This combined with the facts that the gas is at first saturated with water vapor at 75 degrees and 510 lbs. pressure, because of its treatment to remove hydrogen sulfide, and later is recompressed up to 750 lbs. pressure at a point 200 miles from the dehydration plant, made this an unusual gas dehydration problem. Approximately 1000 miles of main line is protected from condensate and hydrate formations under varying pressures and temperature conditions by a single dehydration plant, partially dehydrating up to 80 MM c.f. of gas per day economically with the minimum operation difficulty.

A temperature and pressure survey of the pipe line made during 1936-37 showed that a dewpoint of 35 degrees F. at 500 lbs. pressure would be sufficiently low to give the necessary protection throughout the main line. From this survey a plant, designed and built by Parkhill-Wade and Stearns Rogers Co., was placed in operation early in January, 1938.

Calcium chloride brine was chosen as a dehydrant, and since this solution will only lower the dewpoint approximately 20° below the temperature of the gas being dehydrated, it is necessary to precool the gas before contact with the brine in order to reach the desired dewpoint. This is done with three bentube section coolers in both the hot and cold side of a Stearns Rogers downdraft cooling tower.

The contactors are three 4 ft.-6 in. diameter, 22 ft.-6 in. four-tray, bubblecap towers equipped with liquid level controls and built-in mist extractors on both the inlet and outlet gas compartments. The mist extractor on the inlet gas removes carryover from the sulphur removal plant and any condensate that may form as a result of the precooling.

The gas is precooled during the winter down to 55° F. but not below this temperature because of the probability of hydrate formation in cooling coils, resulting in freezeups.

The brine is circulated by means of a 8x2x12-in. simplex steam pump at the rate of 15 gals. per minute, five gals. per minute to each contactor. This is a higher rate than actually required, but because of difficulty in proportioning, it is an advantage to circulate an excessive amount. The specific gravity of the solution is maintained at 1.36 by means of an atmospheric pressure, enclosed steam coil, type evaporator which operates intermittently with the steam pressure controlled by a gravitometer float and pilot operated steam valve. This is set to carry 25 lbs. steam pressure in the evaporator coil. This set-up is surprisingly sensitive to the gravity and can be set to maintain accurately the desired specific gravity. No attempt is made to cool the brine; its only cooling is by radiation from the surge tank.

The amount of water vapor absorbed varies from 11 to 23 lbs. per MM c. f. of gas partially dehydrated, the lower amount being absorbed during the winter. The brine solution loss is practically nil and the steam consumption very low. The regular sulphur removal plant operator takes care of the dehydration plant, which requires but a small amount of his time. The equipment is designed so that an atmosphere of natural gas is present at all times in the surge tank, gravitometer, and evaporator in order to prevent corrosion. The evaporator is made of Everdur alloy, the balance of the equipment being iron or steel. Indications are that an electrolytic action takes place between the alloys and iron with the brine as an electrolyte and it may be advisable to avoid the use of alloys in calcium chloride brine dehydration plants.

The dew point is determined with the Bureau of Mines type tester as described in their bulletin RI-3399. This instrument directly indicates the dew point by reading the temperature of a gradually chilled mirror placed in the gas stream and in a pressure chamber in which a peep-hole of transparent lucite is installed. The spot of moisture forms on the chilled mirror and usually can be readily seen by placing a small wire about one-fourth in. away from the chilled mirror and arranged so as to cast a shadow. We were better able to distinguish the dew point by watching the shadow disappear as the film formed on the mirror. This tester, a light, compact instrument, gives excellent results.

Operating costs, direct charges only, are as follows:

	Cost per MM c.f. of gas
1. Operation and maintenance labor	$.0372
2. *Steam and Power (Steam @ .0005 per lb.; power @ .006 per kw.	.0125
3. Chemical make-up	.005
4. Water make-up for system (Water @ .0007 per gal.)	.02
Total	$.0702

* Electric power only used for lights. Steam driven pumps used throughout.

The results of dehydration on main line efficiency and maintenance are all favorable. Before the plant was placed in operation, numerous freezeups occurred during the winter months on the section of main line beyond the station at which the pressure was boosted up to 750 lbs. After the dehydration plant was placed in operation not one single freeze-up occurred on the main line in spite of weather conditions which ordinarily would cause them. Efficiencies as calculated by Weymouth's formula rose from less than 70 per cent to over 100 per cent on several sections.

The graph in Fig. 1 shows the theoretical relation between dew point and pressure for two dew points (curves B and C), one of which has been checked experimentally as shown in curve A.

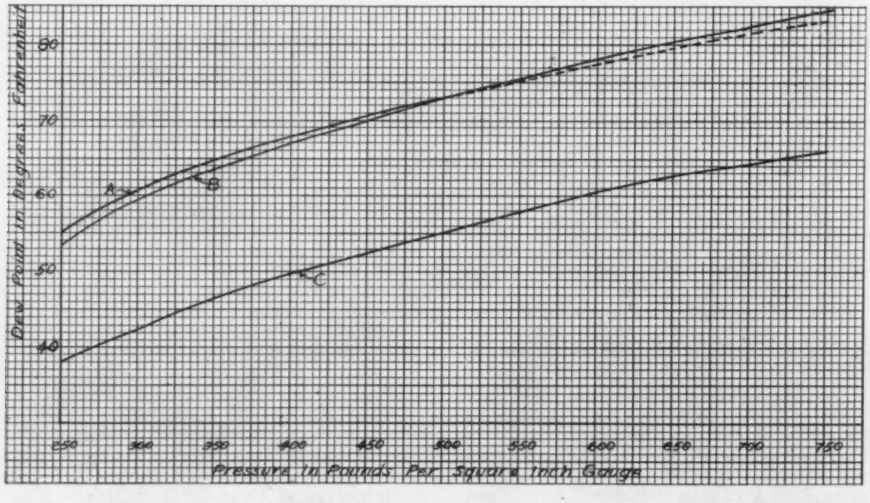


FIG. 1. Relation between dew point and pressure. (A) Curve from experimental data. (B) Theoretical curve. (C) Theoretical curve.

Centrifugal Water Pumping System For Transmission Pipe Line Gas Cooling Towers

By HARRY J. SMITH

Pacific Gas and Electric Company

THE Pacific Gas and Electric Company's Kettleman Hills compressor station was increased in capacity in 1935. This increase in capacity made it necessary to lengthen the atmospheric gas cooling tower, to accommodate the larger volume of water required for cooling the gas. Since the electric generating capacity is limited, it was necessary to install a water pumping system that would be especially economical in power.

The gas cooling tower has a total length of 240 ft. with a deck width of 12 ft. and a height of 40 ft. This gas cooling tower required a centrifugal water pump having a capacity of 4100 gals. per minute or 1.42 gals. per minute per sq. ft. of deck area, but from test 1.3 gals. per minute per sq. ft. was the maximum rate for this tower.

The gas cooling tower centrifugal water pump of 4100 gals. per minute has a total head of 55.38 ft., and is direct connected to a 75 hp. variable speed induction motor, 1800 revolutions per minute synchronous speed, three phase, 60 cycles, 440 volts and a resistor for 50 per cent speed reduction.

The compressor station has two other variable speed motor driven centrifugal water pumps, one of 60 hp. for the jacket water and the other of 50 hp. for the jacket water cooling tower. Each has a resistor for 50 per cent speed reduction.

The electric generating plant consists of three units, direct connected to gas engines and each generator has a rating of 135 kw. Should it happen that two of the generator units were down for repair, it would be possible to keep the load within the rating of one generator by reducing the speed on the three variable speed motors, thereby reducing the horsepower of each pumping unit and still have sufficient water to keep the station in operation. Furthermore, the variable speed motors with 50 per cent speed reduction have a low starting current, which is important with gas engine driven electrical generators. They also give better control for varying the volume of water necessary for cooling the gas.

The suction and discharge piping for the centrifugal pump must be as large as will be economical so that the overall cost will be a minimum. The friction losses in pipe fittings in terms of equivalent lengths of straight pipe were those given in the *Cameron Hydraulic Data Handbook*, and for friction loss in pipe lines, the calculations were based on the Williams and Hazen formula.

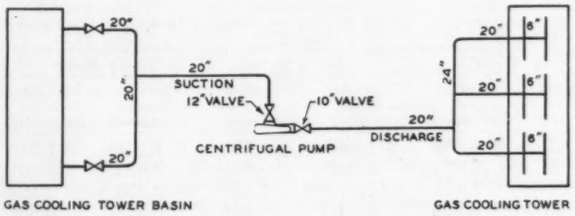


FIG. 1. Piping arrangement for gas cooling tower—Kettleman Hills compressor station.

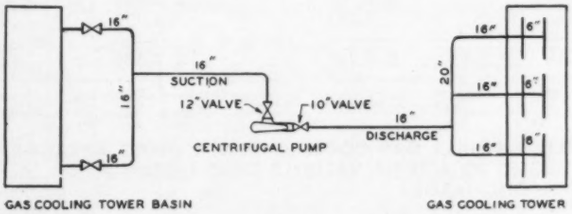


FIG. 2. Piping arrangement for present gas cooling tower installation—Kettleman Hills compressor station.

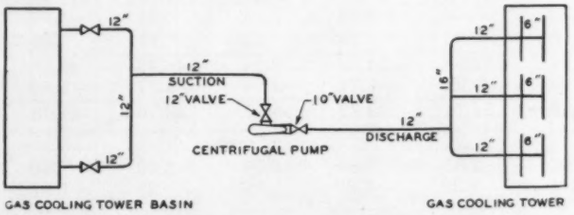


FIG. 3. Piping arrangement for gas cooling tower—Kettleman Hills compressor station.

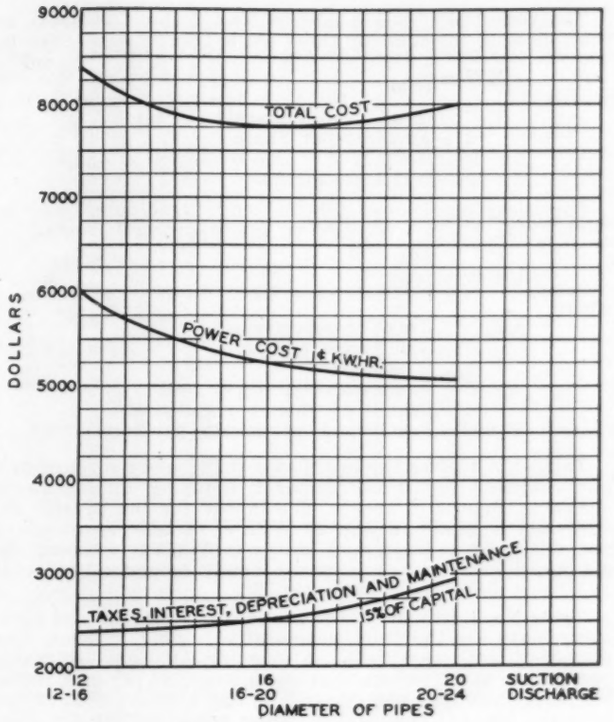


FIG. 4. Yearly operating cost on various sizes of pipes based on full load.

$$S = \left[\frac{V}{1.318\,C\quad R^{0.63}}\right]^{1.85}$$

where

S = Friction loss in feet per foot
V = Velocity in feet per second
C = 100

$$R = \text{Hydraulic radius} = \frac{\text{Diameter of pipe in feet}}{4}$$

For the amperes used in Tables Nos. 3 and 4 the following formula was used for three phase transmission circuits.

$$I = \frac{KW\ 1000}{\sqrt{3}\ E\ (P.F.)}$$

where

I = Amperes per phase
KW = three phase kilowatts measured at the switchboard .
E = 480 volts, phase to phase
P. F. = Power factor
$\sqrt{3} = 1.73$
1000 = Watts per kilowatt

The power loss used in Tables Nos. 3 and 4 is based on the following formula for three phase transmission circuits.

$$KW = \frac{3\ I^2\ R}{1000}$$

where

KW = three phase kilowatts (power loss)
I = Amperes per phase
R = Resistance of one conductor in ohms
1000 = Watts per kilowatt

The brake horsepower for the centrifugal pump used in Tables Nos. 3 and 4 is based on the following formula.

$$B.H.P. = \frac{8.34\ G\ H}{33{,}000\ E}$$

where

B.H.P. = Brake horsepower
G = Gallons per minute
H = Head in feet
E = Pump efficiency in per cent
8.34 = Pounds of water per gallon at 60° F.
33,000 = Foot pounds per minute per horsepower

Table No. 1 gives the installed cost including a spare unit and overhead for three comparative piping arrangements shown in Figs. 1, 2 and 3. The layout for the present installation is shown in Fig. 2. With a variable speed motor for this scheme the actual cost was $16,681, whereas the estimated cost with a constant speed induction motor is $15,089, a difference in cost of $1,592.

Table No. 1 also shows the annual fixed charges and operating costs for the three comparative piping systems. The operating costs were based on pumping 4100 gals. of water per minute at 81 per cent pump efficiency, 88 per cent motor efficiency including line power loss, and a power cost of one cent per kw. hr. The total pumping heads in feet for Figs. 1, 2 and 3 are 53.11, 55.38 and 63.18, respectively.

The total pumping heads for different volumes of water

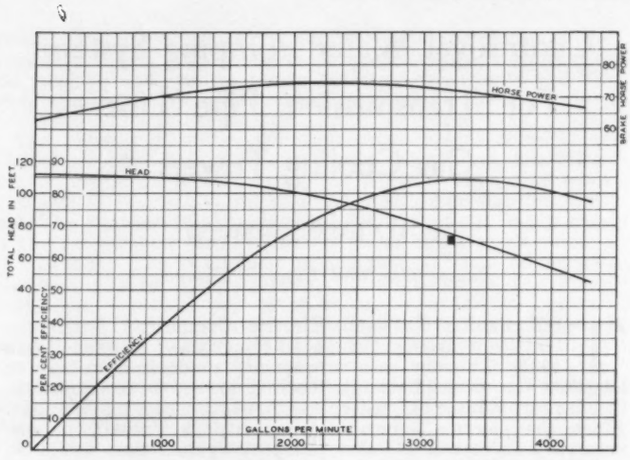


FIG. 5. Characteristic curve of a 10-in. centrifugal pump, operation, constant speed, for gas cooling tower—Kettleman Hills compressor station.

for the present installation are set forth in Table No. 2. The friction losses are calculated and the total pumping heads are those used to plot a curve for establishing the total pumping heads used in Tables Nos. 3 and 4.

The data in Tables Nos. 3 and 4 are for the performance of centrifugal pumps at constant speed and throttled discharge, also at variable speeds with the discharge valve opened. The revolutions of the pump per minute, gallons per minute and kilowatts at the switchboard were obtained from tests. All other figures were calculated.

The variable speed motor efficiencies shown in Table No. 4

TABLE NO. 1. TOTAL COST OF COMPARATIVE PIPING ARRANGEMENTS AND YEARLY OPERATING COST OF GAS COOLING TOWER AT KETTLEMAN HILLS COMPRESSOR STATION, USING A 10-IN. CENTRIFUGAL PUMP DIRECT CONNECTED TO A 75-HP. VARIABLE SPEED MOTOR.

Description	20-in. Suction 20 & 24-in. Discharge (Fig. 1)		16-in. Suction 16 & 20-in. Discharge (Fig. 2)		12-in. Suction 12 & 16-in. Discharge (Fig. 3)	
	75-hp. Motor		75-hp. Motor		100-hp. Motor	
	Variable Speed Estimated	Induction Estimated	Variable Speed Actual	Induction Estimated	Variable Speed Estimated	Induction Estimated
Suction Piping	$ 2,735	$ 2,735	$ 1,960	$ 1,960	$ 1,246	$ 1,246
Discharge Piping	6,878	6,878	4,690	4,690	3,431	3,431
Pump Building	2,453	2,453	2,453	2,453	2,453	2,453
Pumps, Motors and Wiring	7,578	5,986	7,578	5,986	8,776	6,652
Total Installation Cost	$19,644	$18,052	$16,681	$15,089	$15,906	$13,782
Estimated Taxes, Interest, Depreciation and Maintenance 15 per cent of Capital	$ 2,947		$ 2,502		$ 2,386	
Power Cost at One Cent Kw. Hr.	5,041		5,241		5,997	
Total Yearly Operating Cost	$ 7,988		$ 7,743		$ 8,383	

TABLE NO. 2. HEAD AND PRESSURE LOSS IN FEET AT PRESENT KETTLEMAN HILLS GAS COOLING TOWER PIPING ARRANGEMENT (FIG. 2). 10-IN. CENTRIFUGAL PUMP DIRECT CONNECTED TO A 75-HP. VARIABLE SPEED MOTOR—16-IN. SUCTION, 16- AND 20-IN. DISCHARGE.

Description	Gallons per Minute					
	4100	4000	3000	2000	1000	0
Static head, center of pump to distribution header	45.38	45.38	45.38	45.38	45.38	45.38
Loss in discharge piping	8.58	8.22	4.95	2.43	.64	.00
Loss in spray piping	1.42	1.36	.75	.40	.11	.00
Total pumping head in discharge	55.38	54.96	51.08	48.21	46.13	45.38
Suction head	0.00	— .21	—1.71	—2.74	—3.37	—3.60
Total pumping head	55.38	54.75	49.37	45.47	42.76	41.78
Static head, center of pump to top of water in cooling tower basin	3.60	3.60	3.60	3.60	3.60	3.60
Loss in suction piping	—3.60	—3.39	—1.89	— .86	— .23	—0.00
Suction head	0.00	.21	1.71	2.74	3.37	3.60

TABLE NO. 3. PERFORMANCE OF A 10-IN. CENTRIFUGAL PUMP DIRECT CONNECTED TO A 75-HP. VARIABLE SPEED MOTOR—OPERATION, CONSTANT SPEED, THROTTLED DISCHARGE (FIG. 6).
(Gas Cooling Tower, Kettleman Hills Compressor Station)

Revolutions per Minute	Gallons per Minute	Total Head in Feet	Kilowatts at Switchboard	Power Factor	Calculated Amperes	Calculated Line Loss Kilowatts	Input to Motor Kilowatts	Input to Motor Horsepower	Motor Efficiency	Brake Horsepower of Motor and Pump	Pump Efficiency	Horsepower Loss in Motor
1715	4147	55.70	60.38	.89	81.69	1.80	58.58	78.53	.9	70.68	.83	7.85
1710	4107	55.40	61.15	.89	82.76	1.85	59.30	79.49	.9	71.54	.80	7.95
1710	3847	53.70	61.15	.89	82.76	1.85	59.30	79.49	.9	71.54	.73	7.95
1720	3647	52.50	61.15	.89	82.76	1.85	59.30	79.49	.9	71.54	.67	7.95
1720	3453	51.60	61.54	.89	83.26	1.87	59.67	79.99	.9	71.99	.63	8.00
1715	2967	49.20	61.92	.89	83.78	1.90	60.02	80.46	.9	72.41	.51	8.05
1715	2800	48.45	62.31	.89	84.31	1.92	60.39	80.95	.9	72.86	.47	8.09
1715	2593	47.63	62.69	.89	84.82	1.94	60.75	81.44	.9	73.30	.43	8.14
1720	1553	44.00	60.77	.89	82.22	1.83	58.94	79.01	.9	71.11	.24	7.90
1725	387	42.00	56.15	.89	75.97	1.56	54.59	73.18	.9	65.86	.06	7.32
1725	0	41.78	50.77	.89	68.69	1.27	49.50	66.35	.9	59.72	.00	6.63

TABLE NO. 4. PERFORMANCE OF A 10-IN. CENTRIFUGAL PUMP DIRECT CONNECTED TO A 75-HP. VARIABLE SPEED MOTOR—OPERATION, VARIABLE SPEED, DISCHARGE OPEN (FIG. 7).
(Gas Cooling Tower, Kettleman Hills Compressor Station)

Point on Controller	Revolutions per Minute	Gallons per Minute	Total Head in Feet	Kilowatts at Switchboard	Power Factor	Calculated Amperes	Calculated Line Loss Kilowatts	Input to Motor Kilowatts	Input to Motor Horsepower	Motor Efficiency	Brake Horsepower of Motor and Pump	Pump Efficiency	Horsepower Loss in Motor
11	1710	4100	55.38	63.08	.89	85.35	1.97	61.11	81.92	.89	72.91	.79	9.01
10	1680	4093	55.30	58.46	.89	79.10	1.69	56.77	76.10	.87	66.21	.86	9.89
9	1640	3913	54.10	58.27	.89	78.84	1.68	56.59	75.86	.85	64.48	.83	11.38
8	1590	3726	53.00	54.23	.85	76.83	1.59	52.64	70.56	.83	58.57	.85	11.99
7	1540	3480	51.65	50.77	.85	71.93	1.40	49.37	66.18	.81	53.61	.85	12.57
6	1450	3086	49.80	44.42	.85	62.93	1.07	43.35	58.11	.75	43.58	.89	14.53
5	1370	2733	48.20	39.23	.85	55.58	.83	38.40	51.48	.71	36.55	.91	14.93
4	1250	2153	46.00	33.46	.75	53.73	.78	32.68	43.81	.65	28.48	.88	15.33
3	1090	1110	42.96	23.08	.70	39.71	.43	22.65	30.36	.55	16.70	.72	13.66
2	1020	280	41.90	16.15	.50	38.90	.41	15.74	21.10	.49	10.34	.29	10.76
1	880	0	41.78	9.23	.50	22.23	.13	9.10	12.20	.35	4.27	.00	7.93

were obtained from the motor manufacturer and the motor efficiencies range from 89 to 35 per cent for the speeds used. The brake horsepower of the variable speed motor is computed from the efficiency and the input horsepower at each of the reduced speeds.

The annual fixed charges and operating expenses shown in Fig. 4 are plotted from Table No. 1. The present installation is the most economical, having a total yearly operating cost of $7,743. Taxes, interest, depreciation, maintenance and power are the only variables. All other factors, including labor, remain constant.

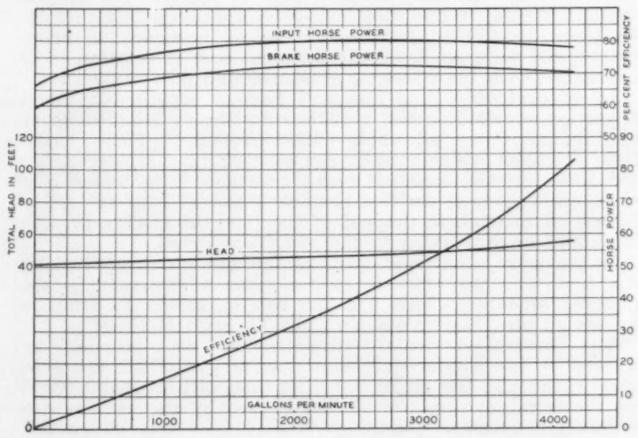


FIG. 6. Curve of a 10-in. centrifugal pump direct connected to a 75-hp. variable speed motor; operation, constant speed, throttled discharge—gas cooling tower, Kettleman Hills compressor station.

Fig. 5 shows the characteristic curve of the 10-in. centrifugal pump purchased for this installation. The head is 73 ft. at 3,250 gals. of water per minute and, by keeping the friction loss in the suction and discharge piping at an economical head, it was possible to increase the volume to 4100 gals. per minute.

For a variable speed installation, the manufacturer of the centrifugal pump should be requested to furnish a curve showing the characteristics of the pump for varying volumes at reduced speeds instead of the characteristic curve at constant speed as shown in Fig. 5.

The characteristics of the 10-in. centrifugal pump operating at constant speed with discharge throttled for varying the volume is shown in Fig. 6 and is plotted from data in Table No. 3. The efficiency of the pump is exceedingly poor due to throttling of the discharge valve. This method of throttling gives a flat brake horsepower curve.

Fig. 7 shows the characteristics of the 10-in. centrifugal pump operated at different speeds with the discharge valve open and is plotted from data in Table No. 4. The volume was varied by reducing the speed with a variable speed motor. This curve shows that with reduced volume the brake horsepower decreases and the efficiency is improved over the efficiency shown in Fig. 5.

In Fig. 8 are shown two curves for brake horespower for this centrifugal pump operated at different speeds. One curve is plotted from Table No. 4 and the other curve is calculated on the basis that the brake horsepower varies as the cube of the speed.

In an article on centrifugal pumps by Michael D. Aisenstein in *Gas Engineers' Handbook*, 1934, page 476, it is stated that (1) The capacity varies as the first power of the

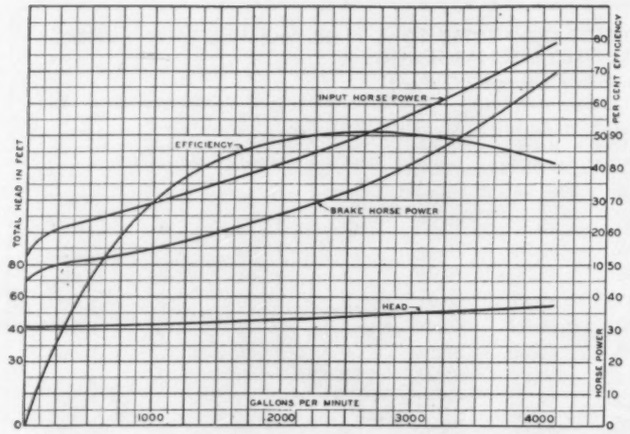


FIG. 7. Curve of a 10-in. centrifugal pump direct connected to a 75-hp. variable speed motor; operation, variable speed, discharge open—gas cooling tower, Kettleman Hills compressor station.

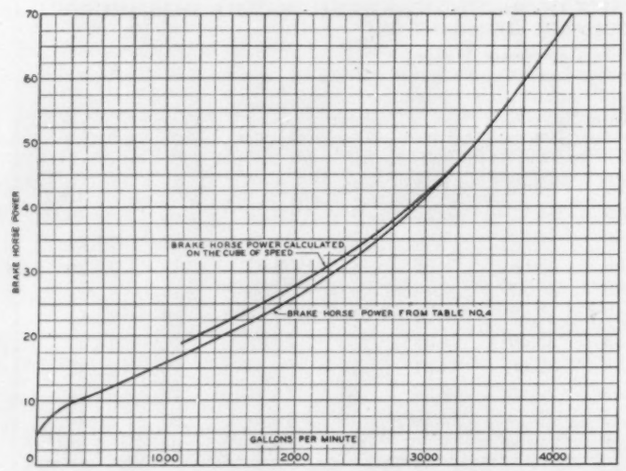


FIG. 8. Curves of a 10-in. centrifugal pump direct connected to a 75-hp. variable speed motor; operation, variable speed, discharge open, calculated brake horse power—gas cooling tower, Kettleman Hills compressor station.

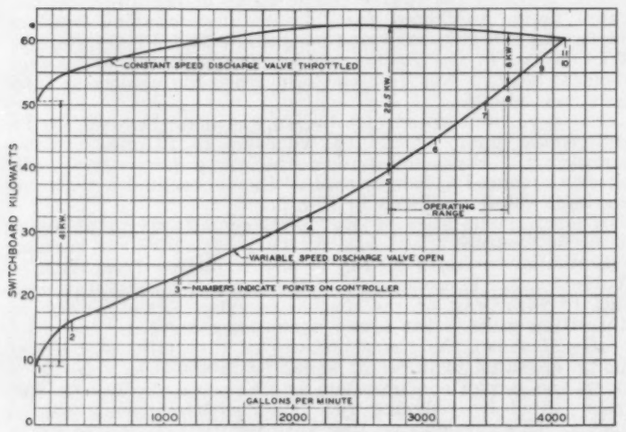


FIG. 9. Curves of a 10-in. centrifugal pump direct connected to a 75-hp. variable speed motor; switchboard kilowatts for constant and variable speed—gas cooling tower, Kettleman Hills compressor station.

speed; (2) the head varies as the second power of the speed; and (3) the horsepower varies as the third power of the speed. Mr. Aisenstein emphasized in the article that this is correct if the variation in speed is not very great. However, the cube of the speed holds quite true over a greater range of volumes as shown in Fig. 8.

The curves for switchboard kilowatts shown in Fig. 9 for constant and variable speed operation were plotted from Tables Nos. 3 and 4. This curve shows the operating range of the centrifugal pump. Operating on the eighth point of the controller, it would recover the additional cost invested in the variable speed motors over the estimated cost of the induction motors, in two years and three months and operating on the fifth point of the controller in 10 months, basing the cost of power at one cent per kw. hr.

Control equipment includes a disconnect switch, oil circuit breaker and controller. The controller is 11-point, nonreversing, oil immersed, with contact in off position for interlocking with magnetic lock on the oil circuit breaker. This prevents the starting of the unit unless the controller is in the off position.

Conclusion

When there is a doubt as to the capacity of a centrifugal pump to be driven by a variable speed motor, a larger capacity pump can be selected without materially increasing operating costs.

The suction and discharge lines for centrifugal pumps should be of sufficient size to be economical and when varying volumes and low starting current are required, variable speed motors should be selected for economy.

If low starting current is required, a resistor can be selected for speed reductions up to and including 100 per cent.

When electric generating capacity is limited, variable speed motors should be selected for flexibility.

Distributed Deliveries—Their Effect on the Capacity of Natural Gas Transmission Pipe Lines

By E. H. FISHER

Coast Industrial Gas Company

PRACTICALLY all of our transmission lines deliver more or less gas at points along the line. What is the cost of transporting gas to these points, as compared to the cost of carrying it through the entire line? This question arises frequently, and is especially pertinent in determining the amount of capacity used by each party in a jointly operated line.

At first glance the answer to our question seems obvious. Why not make the charge proportional to the distance that gas is carried through the line? In cases where deliveries along the line are only a small part of the amount carried through the entire line, this method is approximately correct. As these distributed deliveries increase, however, an error enters, and we must develop a different sort of solution to be consistent with the effect on pressures and flow capacities.

In general, any pipe line will have a certain maximum capacity, which depends upon the maximum inlet pressure and the minimum allowable outlet pressure. These conditions establish the amount of gas that can be carried through the line. In the case of joint operation, it indicates how much each party is entitled to use. Then, as long as all gas is carried through to the end of the line, the charge for use is simply in proportion to the gas transported.

In the more usual case, some of the gas is delivered along the line, and we must introduce some adjustment to the metered amounts. This problem can be solved by what is known as the "Equivalent Straight Through Method."

The "equivalent straight through flow" of a line may be defined as the single equivalent flow of gas which could be carried through the entire length of line, with the same effect on the terminal pressure as was caused by the various distributed deliveries.

The procedure for this calculation is included in the *Gas Engineers' Handbook*, (McGraw-Hill), page 596.

In using this system, the first step is to express each section of line between successive delivery points, as a fraction of the total length. (If the line is made up of

different sizes of pipe, all must be converted to equivalent lengths of some uniform diameter.)

To calculate the equivalent straight through flow for any particular day we then tabulate the quantities carried in each section of line between the successive taps. These quantities may be designated Q_1, Q_2, Q_3, --- Q_n for the "n" sections of line. Each quantity is then squared and multiplied by the fractional length of line, f, through which it passes.

This gives a series of $Q_1^2f_1$ . . . . . (1)
$Q_2^2f_2$
$Q_3^2f_3$
- - - -
$Q_n^2f_n$ which are then added giving a
(summation of Q^2f's)

Since the f's add up to 1.000 it can be shown that the equivalent straight through flow is equal to the square root of this quantity, or

$$Q_T = \sqrt{\text{summation of } Q^2f\text{'s}} \quad . \quad . \quad . \quad . \quad (2)$$

Fig. 1 shows a simple example of the calculation of the equivalent straight through flow of a line from which 50 MM c.f. per day (or any other chosen units) are delivered at each of three points along the line.

After we have this value of Q_T there are two general applications that can be made from it. The first is on the accounting problem of apportioning charges for the different deliveries or groups of deliveries. The second applies to the operating problem of determining the effect of changing the amount or location of deliveries.

The method as recently developed for accounting for the use of a pipe line is as follows:

In any section of line between two successive taps, the total quantity flowing is made up of various quantities that will ultimately be delivered to the different companies a, b, etc. Using the simple case of only two companies, we may say that in any section of line

$$Q_a + Q_b = Q_t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If we now multiply both sides of the equation by Q_t, the total quantity through the section, and by the f representing the fractional length of line in that section, we have

$$Q_tfQ_a + Q_tfQ_b = Q_t^2f \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

In this equation, the right hand side now represents the use of capacity in that section of line, as indicated in (1). The left hand terms then show the portions of that capacity used by the individual companies.

This relation holds true for each successive section of line, and if we add the figures representing use of capacity by each company we have

$$\Sigma Q_tfQ_a + \Sigma Q_tfQ_b = \Sigma Q_t^2f \quad . \quad . \quad . \quad (5)$$

in which "Σ" indicates the summation of these terms for the entire length of line. The total use of capacity by company A, or in other words, the equivalent straight through will then be in direct proportion to the value of

$$\Sigma Q_tfQ_a, \text{ or}$$

$$Q_A = Q_T \frac{\Sigma Q_tfQ_a}{\Sigma Q_tfQ_a + \Sigma Q_tfQ_b} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

in which the upper case subscripts indicate equivalent straight through quantities.

We have already seen in equation (2) that the equivalent straight through flow for the line is equal to the square root of the summation of the Q_2f's, or

$$Q_T = \sqrt{\Sigma Q_t^2f} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Substituting in the denominator of (6), from equations (5) and (7)

$$Q_A = Q_T \frac{\Sigma Q_tfQ_a}{Q_T^2} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

finally

$$Q_A = \frac{\Sigma Q_tfQ_a}{Q_T} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

similarly

$$Q_B = \frac{\Sigma Q_tfQ_b}{Q_T} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

This gives us the equivalent straight through flows, or use of capacity, by the two companies, A and B. It can be seen that the method is adaptable to any number of companies or individual deliveries.

For special cases such as calculating the equivalent straight through of a single delivery, we may simplify the formula to:

$$Q_X = Q_x \frac{\Sigma Q_tf}{Q_T} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

or in another form

$$Q_X = Q_xf_x \frac{Q_{av}}{Q_T} \quad . \quad . \quad . \quad . \quad . \quad (12$$

in which

Q_X is the equivalent straight through flow of the delivery.
Q_x is the actual or metered amount of the delivery.
f_x is the total fraction of line through which Q_x was carried.
Q_{av} is the average total flow in the section of line through which Q_x was carried.
Q_T is the equivalent straight through flow through the entire line.

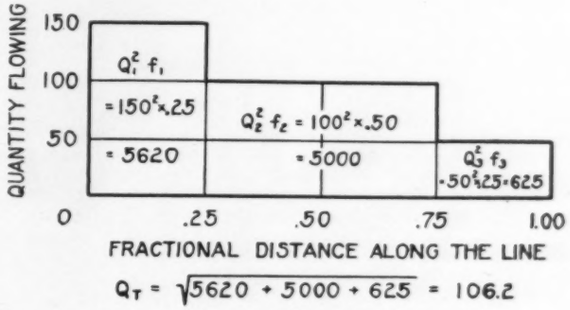


FIG. 1. An example of the calculation of the equivalent straight through flow, Q_T.

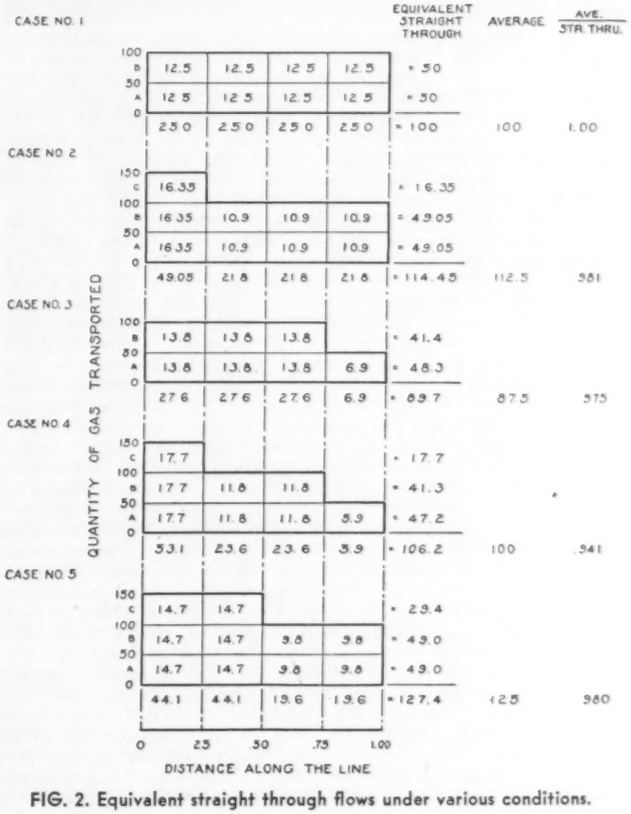


FIG. 2. Equivalent straight through flows under various conditions.

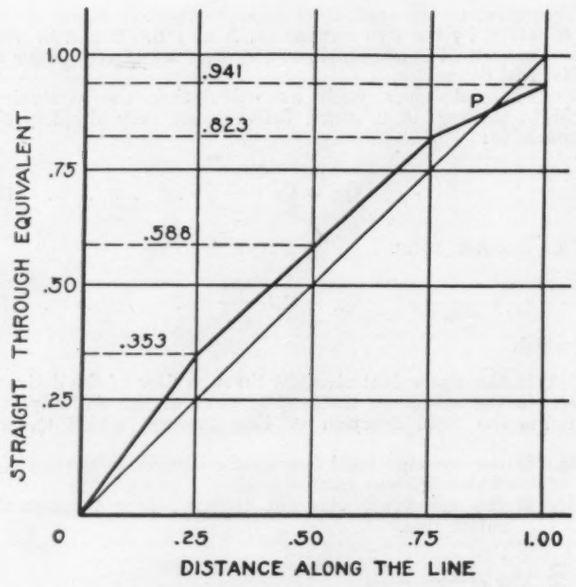


FIG. 3. Amount to be charged for transporting gas various distances, under conditions of Case 4, Fig. 2.

The application of these formulas is illustrated in Fig. 2. We start with the simplest case, Case No. 1, in which two quantities A and B of 50 each are carried through to the end of the line. The average and equivalent straight through flows are identical, each amounting to 50, or a total of 100 for the line. We may further say that for each 25 per cent of the line through which A or B is transported, there is an equivalent straight through charge of .25 x 50 or 12.5.

Turning now to Case No. 2, we see that it is the same except for an additional quantity C, of 50, which is carried through the first quarter of the line.

The equivalent straight through flow, as calculated according to the method in Fig. 1 is 114.45.

By the use of formula (12), the total Q_T of 114.45 has been broken down to show the use of equivalent straight through capacity by each quantity A, B, and C in each quarter of the line. These figures are listed on the diagram. The totals of these figures, as shown on the right are the total straight through charges to quantities A, B, and C, as would result from the application of formulas (9) and (10).

It can be noted that the charge to A, B, or C for handling a unit quantity through any particular section of line is the same. At the same time, the addition of the vertical columns, giving totals of 49.05, 21.8, etc., shows the total use of capacity in each respective section of line, as would be indicated by pressure readings at the ends of the sections. Comparing Case No. 2 with Case No. 1 (Fig. 2), we find that the average flow has been increased from 100 to 112.5, and the equivalent straight through flow has been increased from 100 to 114.45. The ratio of average to straight through has changed from 1.000 to .981. If we now examine formula (12) we find that the straight through charge for any quantity carried through the entire line (f_x=1.000) is equal to the metered amount, multiplied by this ratio of average to straight through.

Thus it appears that we have an inconsistency. A quantity of 50 is carried through the entire line, and is charged with a straight through use of only 50 x .981 or 49.05. The explanation is that in this case a unit quantity of gas, if carried to the end of the line, actually does cause only 98.1 per cent as much pressure drop as it would if the same straight through quantity of 114.45 flowed uniformly through the line. The charge is therefore correct.

We may further note that the added quantity C, is charged with a straight through use of 16.35, while the increase in total straight through from Case No. 1 to Case No. 2 is only 14.45. This difference of 1.90 is the amount by which A and B were decreased, and might be considered as a penalty charge for decreasing the ratio of average to straight through flow in the line. A reduction in this ratio has the effect of increasing the pressure or energy loss per mile that the gas is transported.

The above difference also illustrates the fact that, while formulas (9) to (12) may be used to properly apportion charges for an existing flow, they may not apply directly in the operating problem of calculating the effect of changes in flow. These formulas may be used for operating purposes if the change in flow is small or if known to be of such a nature that the ratio of average to straight through will not be appreciably changed. Otherwise the safest plan is to calculate the total equivalent straight through, before and after the change, and take the difference as the overall effect of the change. This process can be shortened somewhat by a method to be described later.

Case No. 3 in Fig. 2 shows the effect of deducting 50 from the last quarter of the line. The same general effects may be noted as in Case No. 2. Case No. 4 is a combination of Cases No. 2 and 3, and shows the further reduction in ratio of average to straight through. As a result the quantity A is charged with an equivalent straight through use of only 47.2. This case is the same as in Fig. 1. It has been plotted in a different manner in Fig. 3. On this chart the heavy line shows the equivalent straight through charge for a unit quantity when carried any distance along the line. It can be noted that the charge, up to the point P, is more than proportional to the linear distance. In this region, any delivery reduces the ratio of average to straight through. Beyond point P, the reverse is true, and charges are accordingly.

Case No. 5 in Fig. 2 should be compared with Case No. 2, to see the effect of carrying delivery C through an additional quarter of the line. The total straight through is increased by 12.95. A and B are only slightly affected so that almost the same difference of 13.05 is charged in the total to C.

As noted above, there is a short method for comparing total equivalent straight through figures before and after a change in one delivery. Where there are a number of deliveries from the line, the work can be shortened considerably. We start with a given flow condition, for which the equivalent straight through flow, Q_T, has been calculated as in formulas (1) and (2).

The problem is then to find the effect of an additional quantity Q_x, to be carried a total fraction f_x along the line. In the first section of line we originally had Q_1, but now we have $Q_1 + Q_x$. We used $Q_1^2 f_1$, but now we have

$$(Q_1 + Q_x)^2 f_1 \text{ which is equal to}$$

$$Q_1^2 f_1 + 2Q_1 Q_x^2 f_1 + Q_x^2 f_1 \quad . \quad . \quad . \quad (13)$$

similarly we now have

$$Q_2^2 f_2 + 2Q_1 Q_x f_2 + Q_x^2 f_2$$

Summing these

$$\Sigma Q^2 f + 2Q_x \Sigma Q f + Q_x^2 f_x \quad . \quad . \quad . \quad (14)$$

The first term is equal to Q_T^2, which we have already. The second term may be changed to $2Q_x f_x Q_{av}$, in which Q_{av} is the average total flow previously carried through the section in which Q_x is to be added. It can be calculated or estimated rather easily. The last term may be obtained by direct multiplication. In this form, then, the new total equivalent straight through will be

$$Q_T' = \sqrt{Q_T^2 + 2Q_x f_x Q_{av} + Q_x^2 f_x} \quad . \quad . \quad (15)$$

Similarly if Q_x is to be subtracted from an existing flow

$$Q_T' = \sqrt{Q_T^2 - 2Q_x f_x Q_{av} + Q_x^2 f_x} \quad . \quad . \quad (16)$$

Throughout this discussion we have assumed that on a given pipe line the flow follows the general formula:

$$Q = K\sqrt{P_1^2 - P_2^2}$$

Temperatures and specific gravities have been assumed as constant, and the effects of supercompressibility and viscosity are not considered. The exact solution of our problem with these variables included would be very complicated, and in most instances the effect on results would be very slight. Examination of individual cases will indicate whether these variables have any appreciable effect, and if so, a correction can be applied by approximate methods which will give results within the required limits of accuracy.

The writer has attempted in this paper to establish a direct and logical approach to a problem which in the past has been either avoided or solved by rather roundabout methods.

The Detection and Mitigation of Pulsation in Orifice Meters

By T. K. M. SMITH
and
R. E. MORTER

Industrial Fuel Supply Company

WHEN we look back into the past several years, we well realize that during that time numerous advancements have been made in the progress of fluid measurements by the orifice meter. These accomplishments have resulted through the various modifications in metering equipment specifications and design brought about both by the manufacturer and user of such equipment. Such useful changes have offered many conveniences, as well as greater accuracy. Also of great value has been the adoption of universal standards and mathematical procedure.

While these refinements in gas measurement practice have been readily accepted, there still remains another problem which by no means is new, and one which we must admit that we are still working on. This is that factor which has a disturbing effect upon orifice meter measurements caused by a turbulent or pulsating fluid flow. We have been accustomed to associating the word "pulsation" with those disturbances which are set up in the pipe lines and metering devices either on the intake to, or the discharge from, reciprocating compressors, and from other sources.

Naturally we are concerned with these disturbances, because they impair the accuracy of orifice meter measurement. Unusual cases have been known to exist where errors have been in excess of 200 per cent.

Since a pulsating flow has an influencing effect upon chart records, some attempts have been made to establish certain formulae to express mathematically some definite relation between the differential record, caused by the pulsating flow, to that which might exist if flow conditions were steady. Taking into account the many variables, of which a few may be: the length and size of the gage lines, size of the line and orifice, existing line and differential pressures, and the rapidity and magnitude of the pulsations, it is extremely doubtful if any measurement formula can be advanced to adjust the chart records so as to attain volumetric values closely relating to the true and accurate flow. It is only reasonable to appreciate the fact that the inertia, created by the pulsations, tends to cause the mercury to surge and partially "hang up" in the manometer. The installation of dampening devices or bushings in orifice meter gages to retard the movement of the differential pen, by the restriction of the flow of mercury between the two chambers of the manometer, or by other means, has little or nothing to do with producing greater meter accuracy. We know that in the application of our various flow formulae, the prime requisite is to maintain a steady or uniform flow through the orifice; the design of any flow meter presupposes this principle. As this is fundamentally true, it will be readily understood that the cure for the inaccuracies due to effects of pulsation, should start within the meter tubes and orifice plates, and not through mechanical adjustment to the differential gage, which only provides a chart reader with ideal chart records.

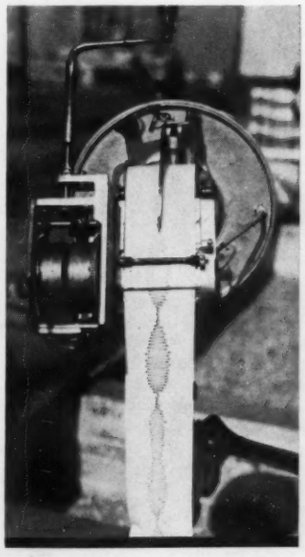


FIG. 1. The pulsometer, showing pulsometer chart.

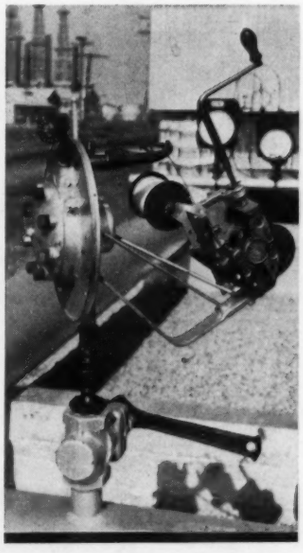


FIG. 2. The pulsometer, side view.

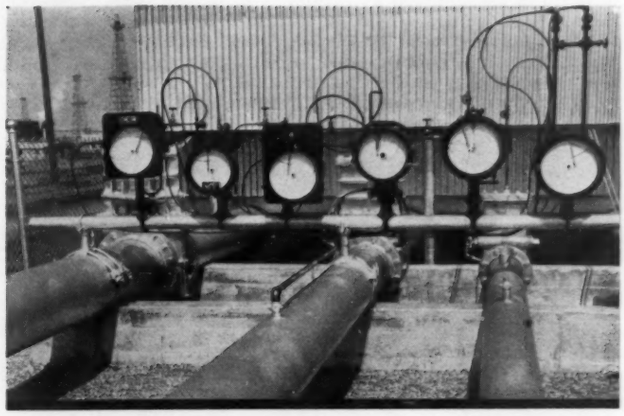


FIG. 3. Assembly of different types of gages (front view).

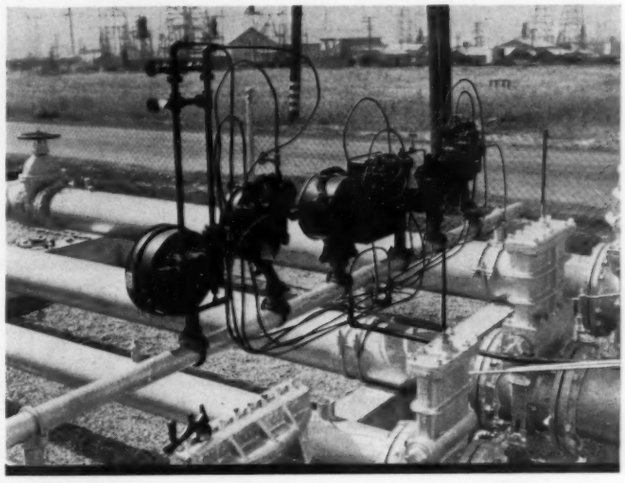


FIG. 4. Assembly of different types of gages (rear view).

The Pulsometer

Cases are known where the differential on the chart would in no way indicate the presence of pulsating flow. Conditions of this sort are due to the sudden pressure variations within the meter tubes or across the orifice plate, generally associated with pulsations occurring in rapid succession. The Industrial Fuel Supply Co., after considerable experimenting, developed what has proven to be a valuable aid in detecting and recording pulsations. This instrument, or pulsometer, is shown in Figs. 1 and 2. It consists essentially of a diaphragm within a suitable housing, which is exposed to the gas stream, and a mechanism for indicating and recording the movement of the diaphragm. After trying out several diaphragm materials, it was found that the ordinary sensitive sylphon bellows proved to be most practical and satisfactory. The bellows is enclosed in a gas tight case, the inlet connection to which can be conveniently attached to a three-quarter in. opening on the pipe line. To avoid leaks which might injure the sylphon bellows, stuffing boxes were eliminated, and the movement of the pen arm by the dia-

phragm is transmitted by means of a torsion tube. However, it has been deemed advisable to install a by-pass connecting the two gas chambers, this being copper tubing of very small inside diameter. This is found to be of great help when filling the pulsometer with the line pressure.

After the installation of the pulsometer, the full line pressure is admitted and any pressure change, however slight, causing a motion of the bellows, is transmitted to the pen which amplifies and records the movement on a strip chart 3½ in. wide. This strip of paper is moved under the pen by a spring-driven mechanism. The rate of the chart travel can be regulated by means of a governor, so as to produce

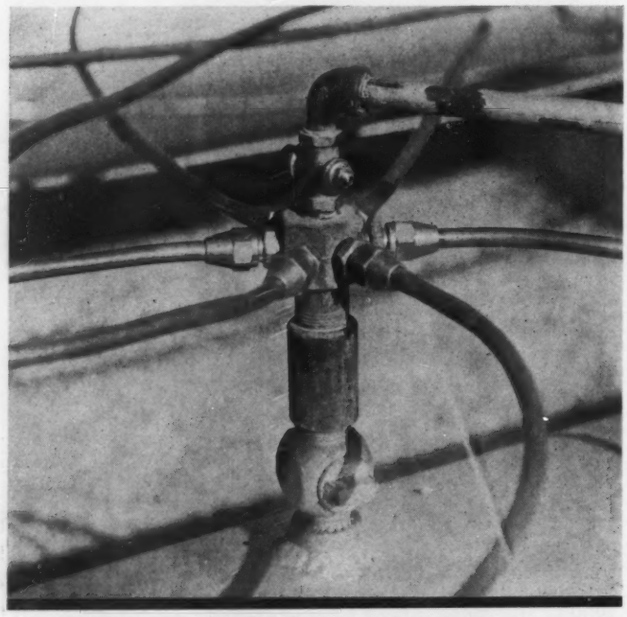


FIG. 5. Special pressure connections for gage lines.

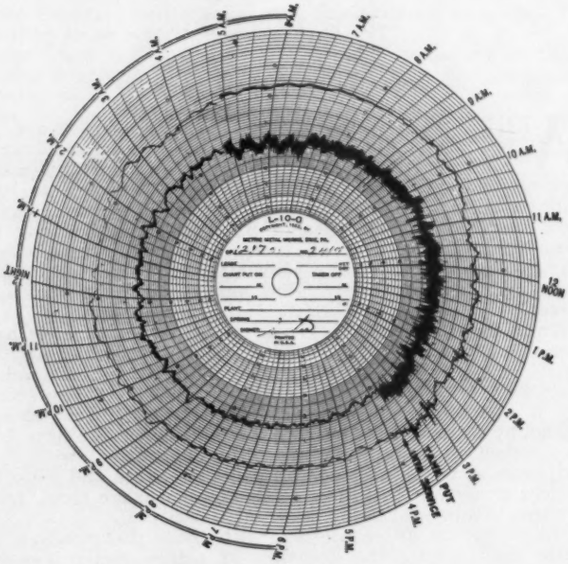


FIG. 6. Specimen chart showing effect of pulsation on the differential record.

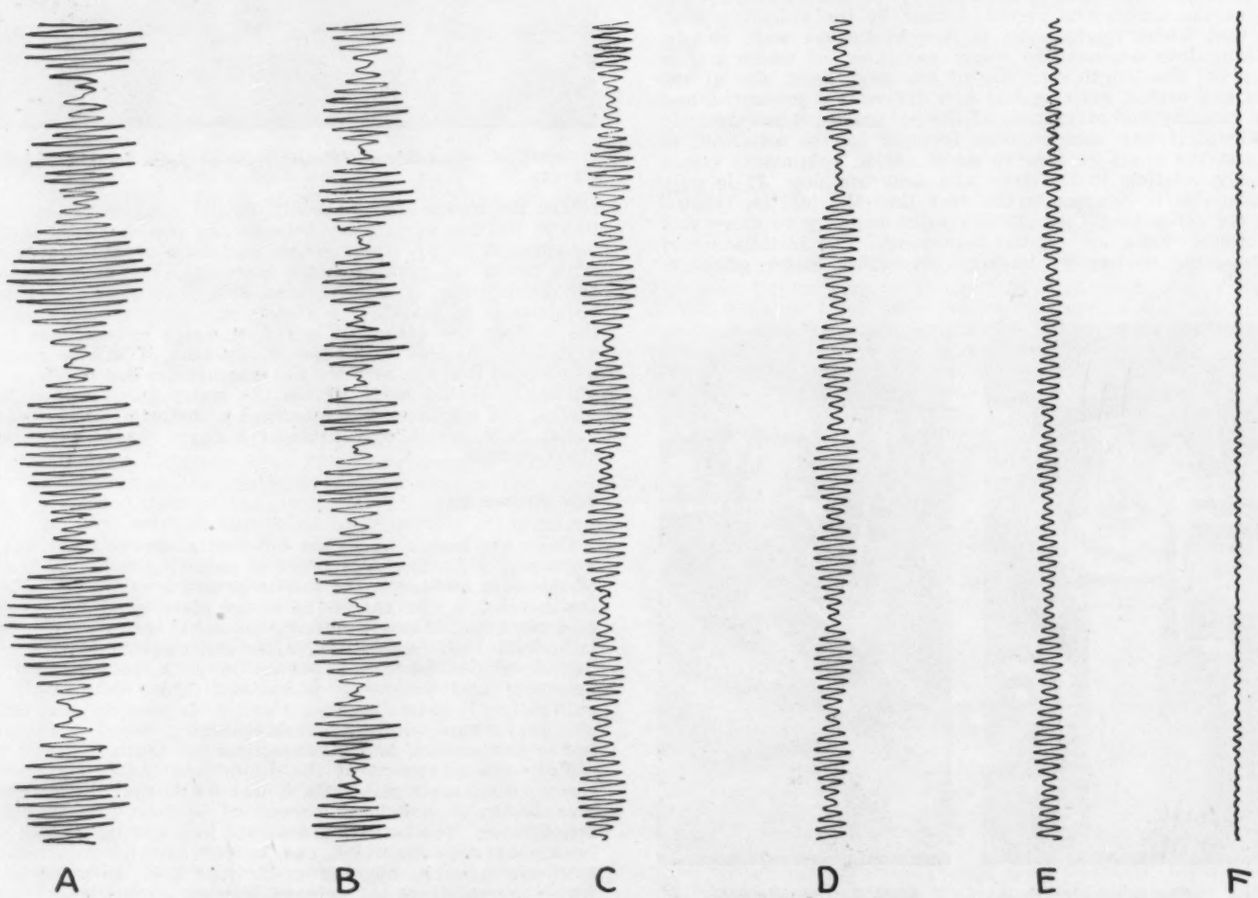


FIG 7. Pulsometer charts showing the effect of throttling.

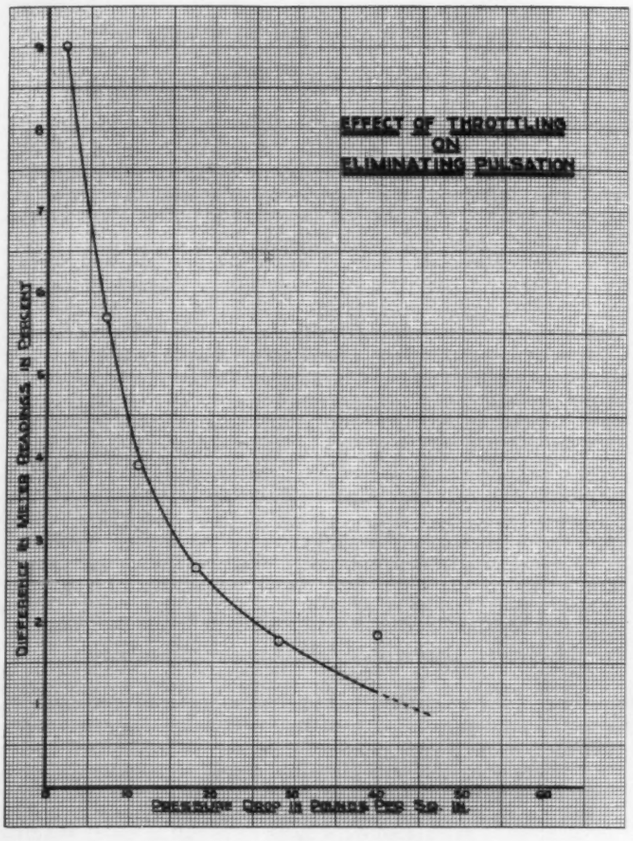


FIG. 8. Curve showing the effect of throttling on eliminating pulsation.

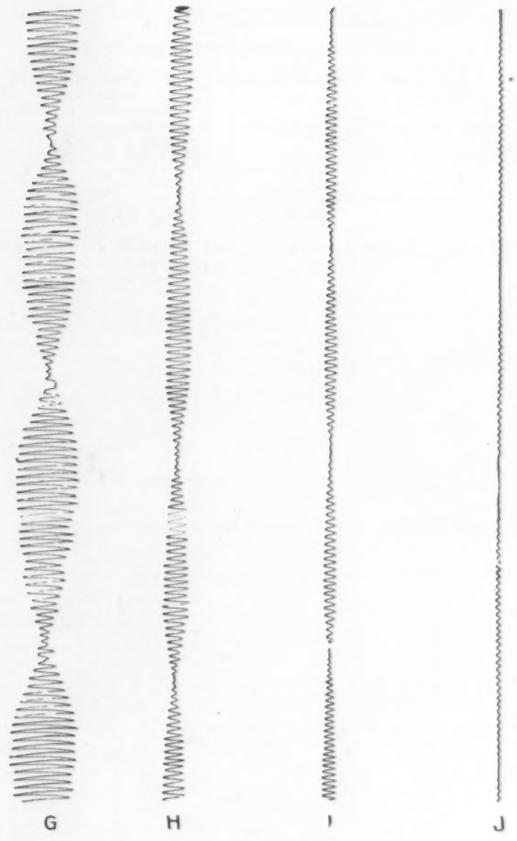


FIG. 10. Pulsometer charts taken before installation of pulsation tank (Fig. 9).

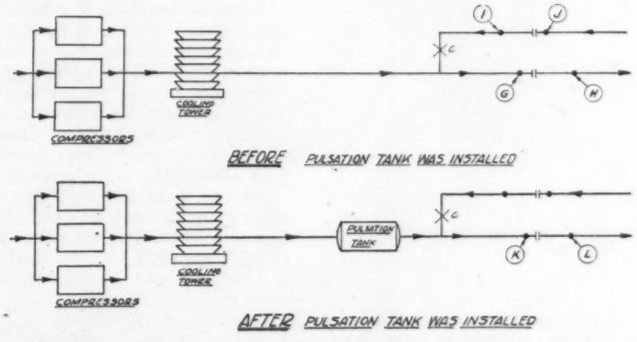


FIG. 9. Flow diagram of meter installation at Industrial Fuel Supply Co.'s Rosecrans compressor plant.

speeds varying from half in. to as much as five inches per per second. Speeds from half in. to one in. per second have been found most satisfactory throughout our tests. No attempt was made to calibrate the pulsometer.

In cases where the pulsation was so violent that a satisfactory chart record was impossible, the size of the opening between the metal bellows and the pipe line was reduced by installing a small orifice. In some cases it was found necessary to reduce the opening to a size corresponding to a No. 50 drill.

Special Test Conducted

As previous tests have been made using only one particular type of differential gage, it was thought advisable to conduct a special test whereby as many makes of gages as were available could simultaneously be put into operation, thus making it possible to check one gage against another. Through the interest and cooperation of six gage manufacturers, we were able to remove any doubt that the errors caused by pulsation were due to our individual equipment. These six gages were installed at our Dominguez Plant, where gas was being measured through a 12-in. meter at 18 lbs. pressure to several 160-hp. compressors.

Figs. 3 and 4 show the assembly of the different types of gages used. Special care was taken in installing these gages; and, as a matter of uniformity, all the gage lines were of equal length. Special pressure connections were used, as illustrated in Fig. 5. All gage line connections were inspected for leaks, and each gage was carefully checked against a water column to insure its accuracy. No static pressures were recorded by any of the gages, but one master pressure recording gage furnished all readings for this purpose. It was the differential record with which we were most concerned. It was noticeable on all six gages that, at the

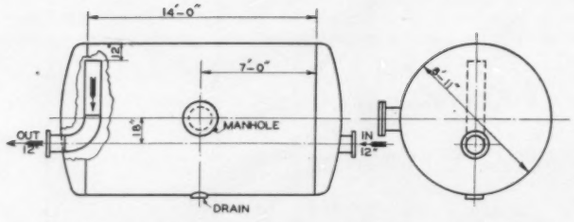


FIG. 11. Design of pulsation tank installed at Rosecrans compressor station (Fig. 9).

FIG. 12. Pulsometer charts taken after the installation of pulsation tank (Fig. 9).

time the pulsation tank was placed into service, an improvement took place in the differential record; that is to say, the width of the line was lessened to some degree.

An individual comparison between the six gages and our field meter was conducted, and the results of their operations over a 10-hour run were compiled and studied. All six gages agreed very closely with one another, pulsation causing the group to record a flow greater than our field meter, located at least a half mile distant. Pulsometer records were taken during this test, and will be referred to later.

Fig. 6 shows an interesting chart which was made under conditions similar to those when the six gages were used. However, in this case, an older type of gage was used and the differential line is much wider when pulsation is present. The pulsation tank was by-passed for the first 11 hours of the day and was put back into service during the remaining 13 hours. Notice particularly the point at which the tank was put into service. There is a difference in differential of at least two in. of water pressure.

Quantities were computed from this chart for nine hours with the tank in service, and nine hours with the tank by-passed, and these figures were compared with the field meter for the corresponding hours, and it was found that, due to the effect of pulsation, there was an average of 2.3 per cent greater volume than measured by the field meter during these hours. This difference compares very closely with the results in the aforementioned test when using six gages.

Mitigation of Pulsation by Throttling

The dampening of a pulsating flow by means of throttling can be done only at a loss of pressure which, to be effective, may require an excessive pressure drop, and is likely to prove a costly procedure. Such methods of quieting the fluid flow are almost prohibitive, especially in low pressure measurement. Efficiency in throttling depends wholly upon the ability to absorb or restrict the pulsations.

We have an excellent record of this procedure, together with pulsometer charts, in a case in which gas is being boosted from 25 to 124 lbs. by two compressors. The plant difference at the start of the tests showed a gain of 9.02 per cent between the intake and discharge meters. Fig. 7, Strip Chart "A" shows a record of the pulsating fluid in the discharge meter. A two-lb. pressure drop existed at the time, from 124 to 122 lbs. (Note the uniformity and the characteristics of the pulsation record.) An eight-in. gate valve was used to throttle the flow, and, upon creating a drop of seven lbs. (from 129 to 122 lbs.), across the partially pinched valve, the error was changed to represent a 5.69 per cent gain.

Fig. 7, Strip Chart "B" represents the pulsation with seven lbs. drop, and it will be noted that the magnitude has been lessened to a slight degree.

The pressure differential was then increased to 11 lbs. (from 135 to 124 lbs.). The meter differences at this time resulted in a difference of 3.90 per cent gain. Fig. 7, Strip Chart "C" illustrates the effect of this pressure drop. Its characteristics are similar to those shown on Strip Chart "A."

Further throttling was done, increasing the pressure drop to 18 lbs., then to 28 lbs. and finally to 40 lbs., resulting in corresponding differences of 2.65 per cent, 1.74 per cent and 1.76 per cent, respectively. In Fig. 7, Strip Charts "D", "E", and "F", show corresponding pulsation records. Strip Chart "F" shows that the pulsating effect was materially reduced, but not completely eliminated.

Taking into consideration that these differences in measurement were calculated on a basis of simultaneously reading the charts, we have a good idea of the corrective effects upon measurement by noting the curve in Fig. 8.

Mitigating Pulsation with Tank in Plant Discharge Line

A study was made where three 200 hp. compressors were being operated, handling 6,500 M c.f. of gas per day, with an intake and discharge pressure of 22½ lbs. and 105 lbs. respectively. The speed of these compressor units varied from 185 to 190 r.p.m. At the outlet of the cooling tower, approximately 30 ft. away, was located a 10-in. orifice meter, through which the total plant discharge gas, plus a quantity of "makeup gas" from another source, was being measured. The schematic arrangement is shown in Fig. 9.

At the time the test was made, no special pulsation eliminating equipment was in use other than the gas cooler, which is made up of two-in. pipes in the tower. The study consisted of determining, at several points in the meter runs, the magnitude and character of the pulsations of the flowing fluid.

Fig. 10, Strip Chart "G" shows a record of the pulsation existing at the upstream (2½ diameters) pressure connection, as indicated at a point marked "G." This location was next to the compressors, and it was natural to expect a severe disturbance in flow conditions. There were 11,900 M c.f. of gas per day being measured through this meter.

Strip Chart "H" is a record of the pulsation at a point on the same meter taken at the downstream (eight diameters) pressure connection, as indicated at point "H" (Fig. 9). This shows a condition still undesirable, although lessened to some extent. This decrease in pulsation is, no doubt, due to the differential pressure of 19.2 in. which existed across the 10 by 4½-in. orifice plate. The line pressure on this meter was 105 lbs. per sq. in.

Strip Chart "I" was taken at the downstream pressure connection (eight diameters) on the meter measuring the makeup gas, or at the point indicated by "I" (Fig. 9). At the time of the test, 5,400 M c.f. of gas per day were being taken into the system at a pressure of 126 lbs. per sq. in., which went to make up the 11,900 M c.f. of gas, as previously stated.

Valve "C," (Fig. 9), was being hand-operated to regulate the flow between the two orifice meters. The pressure drop across this 10-in. gate valve at the time of the test was 21 lbs.; and, while it had some effect in reducing the pulsation,

TABLE NO. 1. DATA ON VARIOUS PULSATION TANK INSTALLATIONS.

(The pulsometer charts in Fig. 13 show the results of the tests made on the pulsation tank installations listed in Table No. 1).

Case No.	Tank position	Tank size	Tank location	Gas rate M c.f. per day	Gas pressure lbs. per sq. in.	Pressure drop through tank	Chart location	Chart
1	Vertical	5′ x 8′	Plant intake	9985	117	0.55 lbs.	Meter side of tank	M
							Compressor side	N
2	Horizontal	9′ x 14′	Plant intake	8950	18	0.1 lbs.	Meter side	O
							Compressor side	P
							Meter side, tank by-passed	Q
3	Horizontal	8′ x 14′	Plant intake	18,558	53	0.6 lbs.	Meter side	R
							Compressor side	S
4	Horizontal	4′ 6″ x 11′	Plant discharge	14,670	104	1.25 lbs.	Meter side	T
							Compressor side	U
5	Horizontal	5′ x 8′	Plant discharge	12,310	126.5	0.1 lbs.	Compressor side	V
							Meter side	W

REMARKS

All strip charts taken through 2-in. connections unless otherwise noted.

Case No. 1—Several compressors.
Case No. 2—Four compressors, 190 to 204 r.p.m. Two charts, P and Q, taken through a No. 50 drill size orifice. Tank shown in Fig. 11.
Case No. 3—Tank shown in Fig. 14.
Case No. 4—Several compressors.
Case No. 5—Cooling coils were located between the tank and compressors which accounts for the relative steadiness of the pulsometer chart on the compressor side.

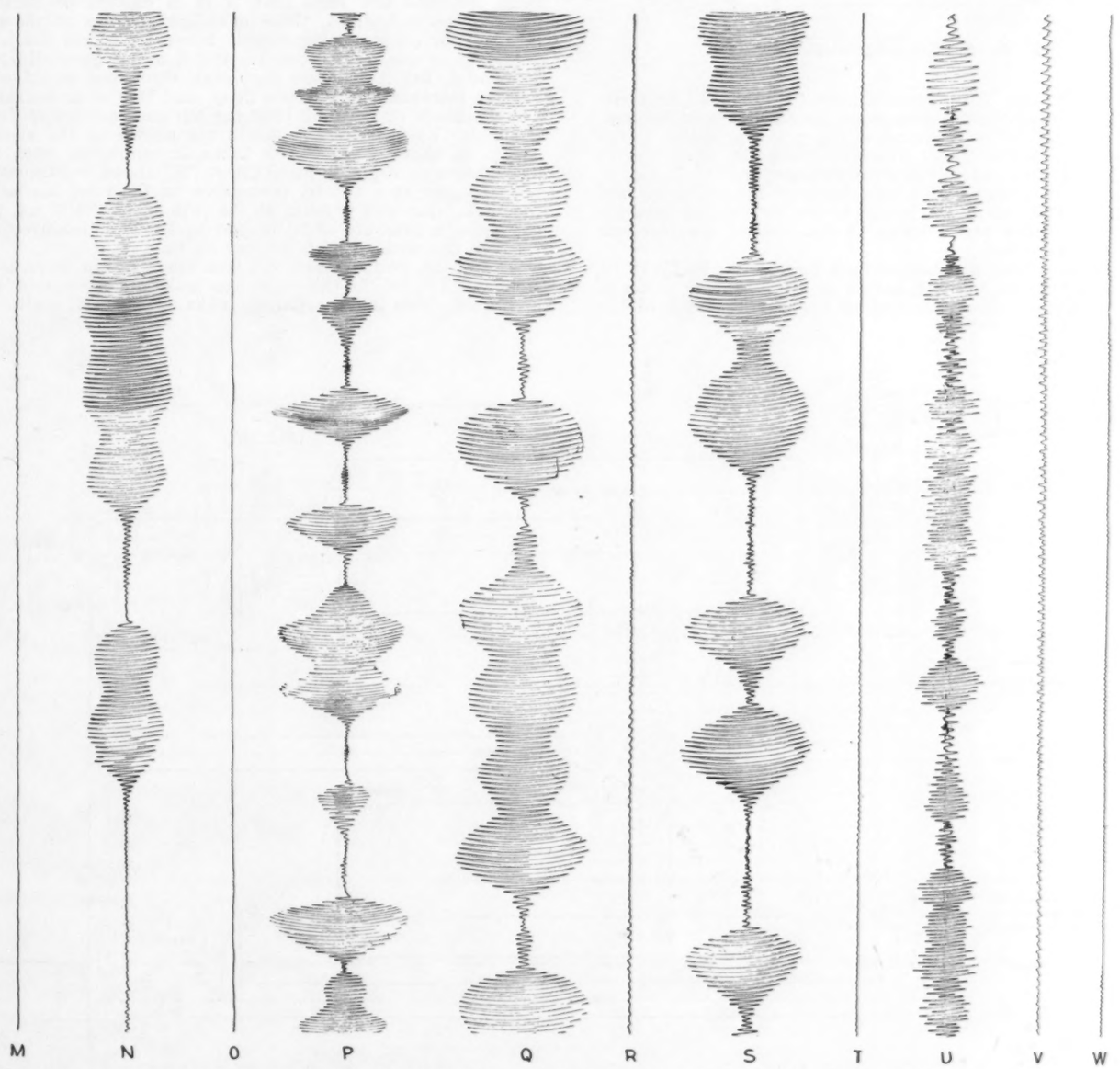


FIG. 13. Pulsometer charts showing the results of tests made on pulsation tanks. (See Table No. 1).

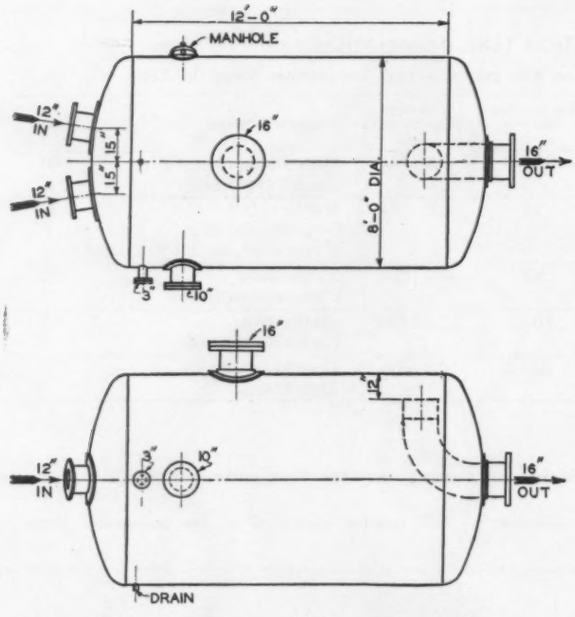


FIG. 14. Another design of pulsation tank.

it is readily seen from Strip Charts "I" and "J" that the pulsations, while less violent, were by no means eliminated.

Strip Chart "J" is a record of the pulsation taken at the upstream (2½ diameters) pressure connection, from the 10 by 4½-in. orifice plate, at a point indicated by "J" in Fig. 9. A further reduction in the magnitude of the pulsation will be noted. This, no doubt, is due to the differential pressure across the orifice plate, which at the time of the test was 15.7 in. differential.

A few days later a pulsation tank four ft. six in. by 11 ft., similar in design to that shown in Fig. 11 was installed between the outlet of the cooling tower and ahead of the orifice meters, as shown in Fig. 9. Valve "C" was completely closed during the second test.

Let us refer to Fig. 12, Strip Chart "K." This record shows no pulsation whatsoever. Likewise, Strip Chart "L," taken downstream from the plate, shows the complete absence of pulsation. The differential at the time of the test was eight in. across a 10 x five-in. orifice plate. The discharge pressure of the compressors was 113 lbs., and gas was being measured at the rate of 4,930 M c.f. per day.

Results of other tests taken at various locations and under different conditions are shown in Fig. 13 and listed in Table No. 1.

Fig. 14 shows another pulsation tank.

Mitigating Pulsation with a Tank with Perforated Inlet Lines

In Fig. 15 a sketch of another type of tank is shown. The inlet connections are such that the gas is permitted to enter the tank at both ends. Five six-in. pipes extend through the entire length of the tank, and are connected at each end to the 16-in. headers. Valves are installed on each pipe entering the pulsation tank, and afford the flexibility of changing inlet areas corresponding to the various rates of flow. Each of these feeder pipes is perforated with two rows of five-eighths in. holes the full length of the inside of the tank, the drillings being staggered and on the lower circumference of the pipes, with 2½ in. centers. There is a total of 860 such holes and their locations are such that if it is desired to further dampen the pulsations, these openings may be submerged in an oil or other sealing liquid. However, it has not been necessary to use this procedure, and it is not generally recommended, for the reason that such throttling would only tend to increase the pressure drop, and this is undesirable. The discharge of the tank is at the top and equidistant from the ends. By-pass arrangements are shown in the sketch.

Fig. 16 shows strip charts taken in connection with the tank shown as Fig. 15. Strip Chart "X" shows a pulsometer record taken at a two-in. connection on the inlet header to the tank. Gas was passing at the rate of 13,000 M c.f. per day under a pressure of 21 lbs. per sq. in. The pressure drop through the tank was 0.5 lbs. per sq. in.

In Fig. 16, Strip Chart "Y" was taken at the same location as "X," but in this case the tank was by-passed and closed off. Note the alternating peaks within each cycle.

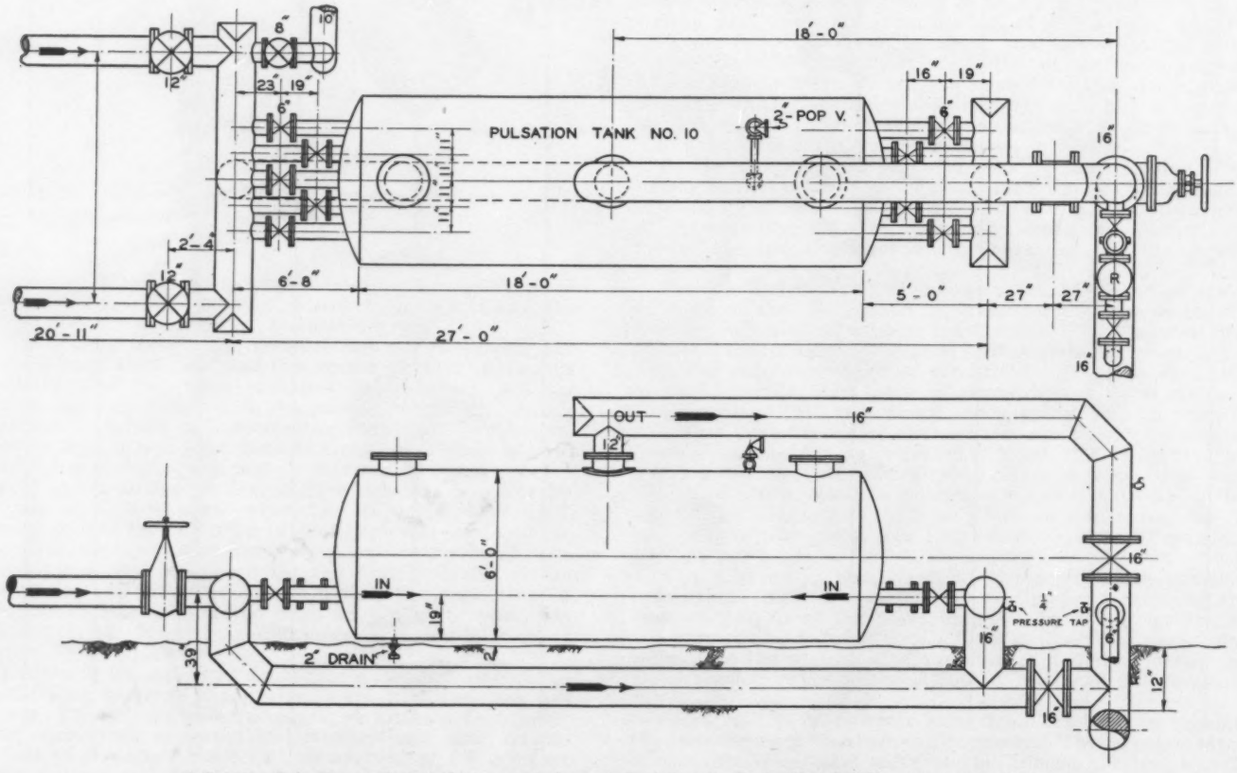


FIG. 15. Pulsation tank installation at Industrial Fuel Supply Co.'s Signal Hill compressor plant.

FIG. 16. Pulsometer charts taken from the tank installation shown in Fig. 15.

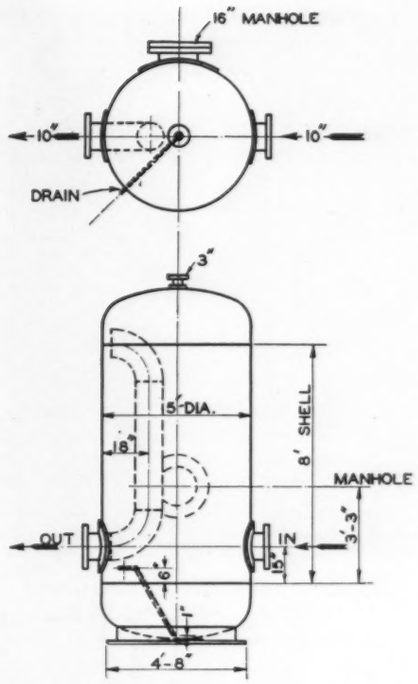
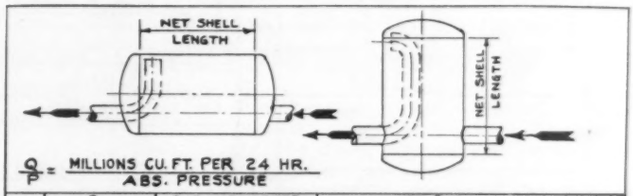


FIG. 17. Vertical pulsation tank installation at Industrial Fuel Supply Co.'s Santa Fe Springs compressor plant.



Q/P	SHELL DIAMETER IN INCHES	NET SHELL LENGTH DISHED HEADS	NET SHELL LENGTH SEMI-ELLIPTIC HDS.
.016	30	3'-2"	2'-0"
.02	32	4'-7"	
.03	36	5'-6"	4'-4"
.04	40	6'-0"	
.045	42	6'-1"	4'-10"
.05	44	6'-3"	
.06	46	6'-10"	
.07	48	7'-5"	6'-0"
.08	51	7'-6"	
.09	53	7'-9"	
.10	55	8'-1"	
.133	60	9'-1"	7'-6"
.15	63	9'-4"	
.20	69	10'-5"	
.25	74	11'-4"	
.30	79	11'-11"	
.35	83	12'-7"	
.40	87	13'-2"	
.45	90	13'-10"	
.50	94	14'-1"	
.55	97	14'-7"	
.60	99	15'-4"	
.65	102	15'-7"	
.70	105	15'-11"	
.80	109	16'-11"	
.90	114	17'-4"	
1.00	118	17'-11"	

FIG. 18. Table showing the proper diameter and shell length for various $\frac{Q}{P}$ values.

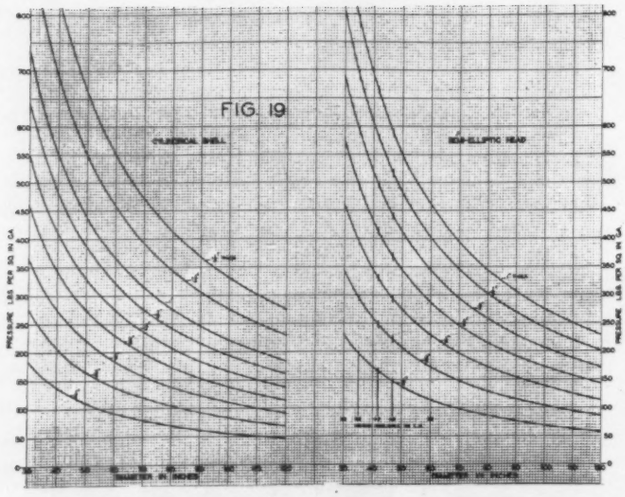


FIG. 19. Curve showing allowable pressure with various plate and head thicknesses. (Cylindrical shell, left, semi-elliptical head, right).

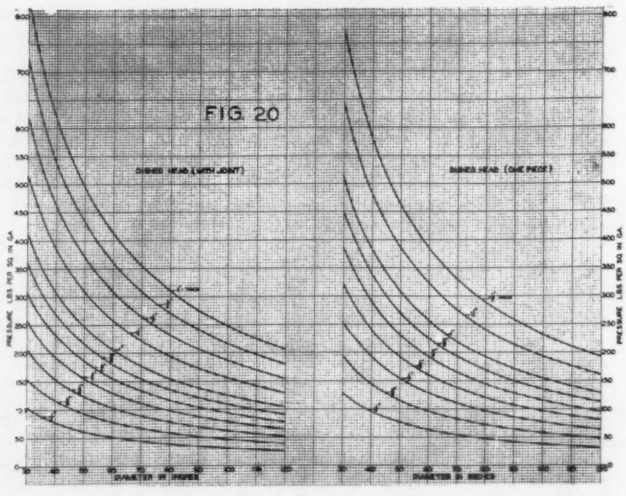


FIG. 20. Curve showing allowable pressure with various plate and head thicknesses. (Dished head with joint, left; dished head, one piece, right).

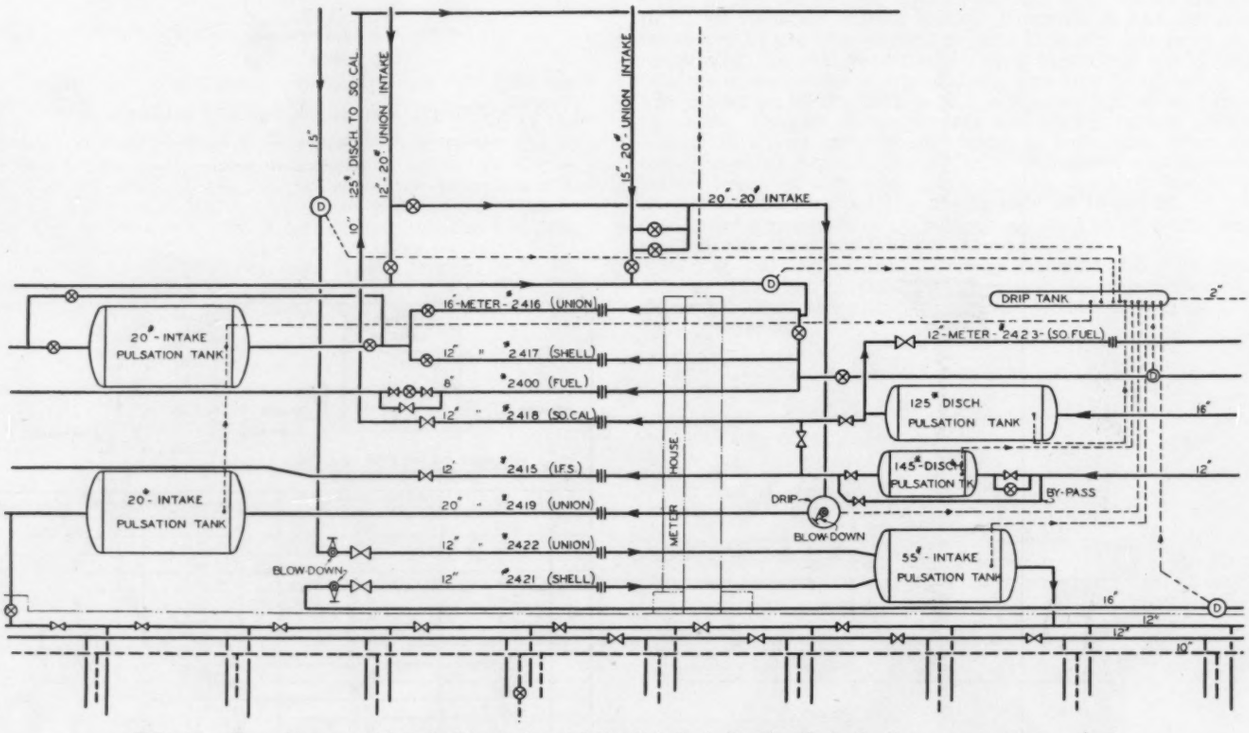


FIG. 21. Flow diagram with pulsation tanks at Industrial Fuel Supply Co.'s Dominguez compressor plant.

Design of Pulsation Tanks

Through the knowledge gained in our studies of detecting pulsation and its elimination from orifice meter measurements, the installation of cylindrical surge tanks of "capacities," in pipe lines was selected as a practical and satisfactory answer to the problem.

Since abrupt pressure changes within the metering equipment have a prominent part in creating errors, many of these tanks are serving a useful purpose in making it possible to arrive more accurately at meter volumes. The inlet and outlet connections are so placed as to permit the gas to travel lengthwise through the tank. As the flow of the incoming gas is allowed to enter the tank abruptly much of the pulsation is immediately dissipated. Also, a very important factor seems to be the arrangement of the outlet of the tank, with its axis 90 degrees from that of the inlet. However, in the case where the pulsation tank was installed vertically, because of space limitations, it was necessary to deviate from our usual procedure. Originally the tank was installed without the elbow on the outlet as shown in Fig. 17, and the results were not entirely satisfactory. However, when the elbow was installed, satisfactory results were obtained. An explanation for this might be that a slight vertical surge may have existed under the flow conditions.

As each metering station possesses its own seemingly strange and peculiar characteristics, it has therefore been necessary to calculate the capacity requirements for each individual case.

In the absence of any rational basis for the design of a pulsation tank, we have formulated the following two rules, based on a number of successful pulsation tanks. The source of pulsation in each case is compressing equipment, the tanks being located either on the intake or discharge line to or from the compressors. The rules are used only as a guide, and the final dimensions of the tank will depend on the sheets

and heads available, the problem being to obtain the greatest volume at the least expense.

Rule 1: Allow 100 cu. ft. of tank volume per MM c.f. of gas per 24 hours, reduced to actual volume under the existing pressure.

$$V = 100\,Q \times \frac{15}{P} \quad \text{or} \quad V = 1500\,\frac{Q}{P}$$

where

Q = flow in millions of standard cu. ft. per 24 hours

P = absolute pressure of the gas.

Rule 2: Make the cylindrical length of the tank 1.75 times the tank diameter. Also the outlet pipe is continued into the tank, as shown in Figs. 11 and 17. Fig. 18 shows the proper diameter and the shell length for various values of Q divided by P.

Figs. 19 and 20 show the allowable pressure with various plate and head thickness. For example, suppose we had 72 MM c.f. per day at 275 lbs.

$$\frac{Q}{P} = \frac{72}{290} = .25 \text{ (approximately)}$$

Shell diameter = 74 in.
Net length = 11 ft., 4 in.

From Figs. 19 and 20, we find a 74-in. diameter cylindrical shell at 275 lbs. falls between a seven-eighths in. and one in. sheet. We can select the one in. plate and increase the diameter to the maximum allowable, viz., 80 in. If we used the seven-eighths in. plate, we would have to decrease the diameter to 70 in.

Using a one piece dished head, the 80-in. diameter tank would take a 1½-in. head plate, while the 70-in. diameter tank would require a 1¼-in. head plate. By adjusting the length to give us a volume of 1500 × .25 = 375 cu. ft., we would have two designs, either one probably being satisfactory. The length can be adjusted by the following equations, dimensions being in feet:

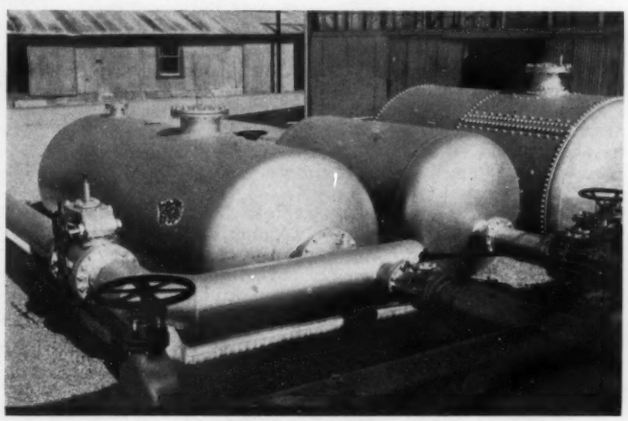


FIG. 22. Close up view of a group of pulsation tanks.

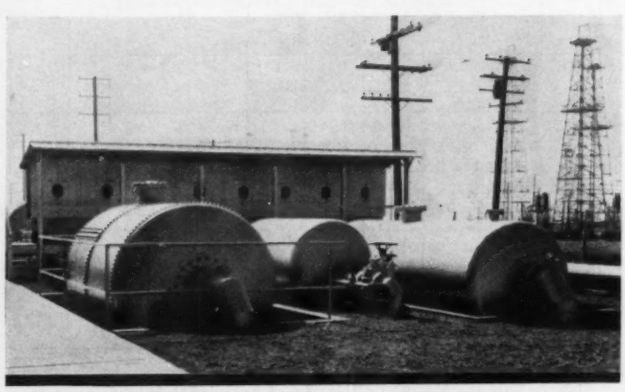


FIG. 23. Another view of a group of pulsation tanks.

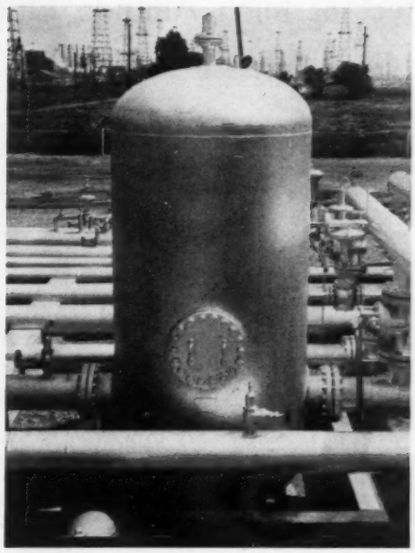


FIG. 24. Vertical pulsation tank installation showing inlet and outlet connections (see Fig. 17).

Dished heads $V = \pi r^2 l + .274\ \pi r^3$ (a)

Semi-elliptic heads $V = \pi r^2 l + .67\ \pi r^3$ (b)

The design now becomes an economic problem and we are ready for bids from the tank manufacturer. The diameters in Fig. 18 were derived from

$$D = 118\sqrt[3]{\frac{Q}{P}} \qquad (c)$$

D is the diameter in inches. Equation (c) was derived from applying the two rules to equations (a) and (b) and averaging the results. In obtaining the net shell length, we assumed a 2½-in. skirt on the dished head and a six in. skirt on the semi-elliptic head.

We have no rules for the size of the inlet and outlet flanges. Very little pressure drop is required, so these flanges are usually kept the same size as the connecting piping.

Fig. 21 shows the flow diagram of meters at the Industrial Fuel Supply Co.'s Dominguez Compressor Plant where several pulsation tanks are installed in connection with the intake and discharge meters.

Figs. 22 and 23 show groups of pulsation tanks. These tanks operate on pressures of 60-, 125- and 250-lbs.

Fig. 24 is the installation of the vertical pulsation tank at the Industrial Fuel Supply Co.'s Santa Fe Springs Compressor Plant.

Closing Remarks

While this report deals with cases in which pulsation would have been an influencing factor upon the accuracy of fluid measurement by the orifice meter had successful means not been employed in suppressing it, it is felt that there still remains need for further investigation into the subject.

Since we have found that each case presents an individual problem, it would not be amiss to have the knowledge as to what effect pulsation would have upon orifice meter measurements where the flowing fluid is either under a vacuum or at extremely high pressures. A study of the effects with various orifice to pipe diameter ratios would also prove interesting.

Further development in connection with the pulsometer will be attempted in order to arrive at, if possible, some sort of correlation between the magnitude and character of the pulsometer chart records, and the errors which might exist resulting from the behavior of the differential recording gage.

We wish to acknowledge with thanks the helpful suggestions and assistance given this committee by the several gage manufacturers as well as to those who aided in the preparation of this report.

Effect of High Altitude Upon Gas Furnace Operation

By JOHN C. MUELLER
and
LOUIS C. MORRIS

Payne Furnace and Supply Company, Inc.

ABSTRACT

Tests were conducted on two gas-fired warm air furnaces to determine the reduction in maximum safe operating rate occasioned by removal from an altitude of 200 feet to 5200 feet above sea level.

This reduction was found to amount to approximately 20 per cent of the rate at sea level.

The reduction in rate necessary to provide the same excess air concentration at 5200 feet as at 200 feet was found to be approximately constant at 20 per cent of the rate at sea level, over a range extending from the minimum safe excess air concentration to an 80 per cent excess over that required for complete combustion. This corresponds closely to the decrease in heating value of a given volume of gas with increase in altitude.

Other factors than combustion may determine the normal heat input rate of an appliance at sea level. Since these factors are not influenced by altitude to the extent that combustion is influenced, the maximum safe input rate at high altitudes may be much greater than is indicated by a study of combustion effects alone.

EARLY in the history of gas appliance testing, it was found that appliances which operated satisfactorily at sea level could not be made to burn the same amount of gas at higher altitudes. The recognition of this fact by the laboratories of the utility companies operating at high altitudes led to an investigation undertaken in the winter of 1932 by the United States Bureau of Standards with the cooperation of the American Gas Association Testing Laboratories. The report of this investigation by Eiseman, Smith, and Merritt (U.S.B.S. Research Paper No. 553) is the most comprehensive publication on this subject available at this time. Upon this report is based the present A. G. A. stipulation that the input rate, as published for sea level conditions, shall be decreased five per cent for each 1000-ft. increase in altitude above sea level.

Since the tests reported by Eiseman, Smith, and Merritt were conducted in a closed chamber, in which the effects of altitude were simulated by a partial exhaustion of the atmosphere to obtain a pressure typical of the barometric pressure at various altitudes, there has been some feeling that the results obtained might not exactly parallel the results which would be observed if an appliance were to be moved bodily from a lower to a higher altitude. It was decided for this reason to run duplicate series of tests on two gas warm air heating appliances, one series of tests on each appliance to be conducted at the Denver Laboratory of the Public Service Co. of Colorado, at an altitude of 5200 ft., after which the appliances were to be returned to the Beverly Hills, Calif., Laboratory of the Payne Furnace and Supply Co. at an altitude of 200 ft., and the tests repeated. To insure that the tests would as nearly as possible duplicate each other, the engineer who conducted the tests in Beverly Hills, previously went to Denver to observe and assist in the test work conducted there.

Equipment and Test Procedure

Equipment at Denver consisted of a wet test gas meter for accurately determining the gas input to the appliance, an Orsat flue gas analysis apparatus, potentiometer pyrometers for temperature measurement, Mines' Safety Appliance Co. Navy type carbon monoxide indicator, barometer, and calorimeter. Equipment at Beverly Hills was the same with the exception of the carbon monoxide indicator, barometer, and calorimeter. The barometric pressure and heating value of the gas were determined daily from reliable sources, however.

The appliances tested were two typical gas warm air furnaces, the first a gravity type with a normal heat input rate of 90,000 B.t.u. per hour; the second a winter air conditioner with a normal heat input rate of 100,000 B.t.u. per hour. These are referred to throughout the report as 90 A and 100 WAC, respectively.

Each appliance was tested at each altitude as follows:

The appliance was set up in a normal manner. The gas rate was adjusted to approximately 60 per cent of normal by reducing the manifold pressure, and the primary air adjusted by eye to a soft flame, just avoiding yellow tips. The gas input rate was measured; a sample of combustion products was analyzed for carbon dioxide and oxygen, the per cent of excess air in the combustion products was computed, and in the series of determinations at Denver the products were analyzed for carbon monoxide.

The gas input rate was increased a few thousand B.t.u. at a time and the observations noted above repeated at each rate. The maximum rate taken was that at which incomplete combustion was first obtained. A sufficient length of time was allowed to elapse between the initial adjustment at each gas rate and the subsequent observations to insure that equilibrium had been reached.

Results of Test

The data of primary interest in this investigation is the decrease in amount of excess air in the combustion products with increase in altitude at any given heat input rate. Since in any particular appliance, the amount of excess air represents the factor of safety from a combustion standpoint, the decrease in excess air at the same gas rate on changing from a lower altitude to a higher, is a measure of the approach of the appliance to the point of incomplete combustion. Eiseman, Smith, and Merritt (ibid.) have shown, for instance, that the production of carbon monoxide by a water heater which they tested began when the same carbon dioxide concentration in the flue gases was reached at conditions representing altitudes of 200, 2900, 5800, and 10,900 ft. respectively. The test results for the two furnaces are shown graphically in Figs. 1 and 2, respectively. It will be noted that the increase in the input rate between the two altitudes is approximately constant at any given excess air concentration. For furnace 90 A, at 90 per cent excess air, the input at Denver is 78.5 per cent of that at Beverly Hills. At 12 per cent excess air, at which carbon monoxide was first observed, the ratio is 79.5 per cent. For furnace 100 WAC, at 80 per cent excess air, the ratio is 73.3 per cent, at 50 per cent excess air 79.6 per cent, and at 11 per cent excess air corresponding to the initial production of carbon monoxide, the ratio is 84.6 per cent. Thus we may say that at an altitude of 5200 ft., the safe input rate of these two furnaces is reduced to approximately 80 per cent of the safe input at sea level.

In Fig. 3, these data are replotted as the reduction in maximum safe input rate as a function of altitude. With them are plotted for comparison curve H of Fig. 4 of the Bureau of Standards report, covering similar data on a warm air furnace tested in the altitude chamber. As the Bureau of Standards report shows for four different types of appliances that maximum safe heat input rate is a linear function of altitude, the curves for furnaces 90 A and 100

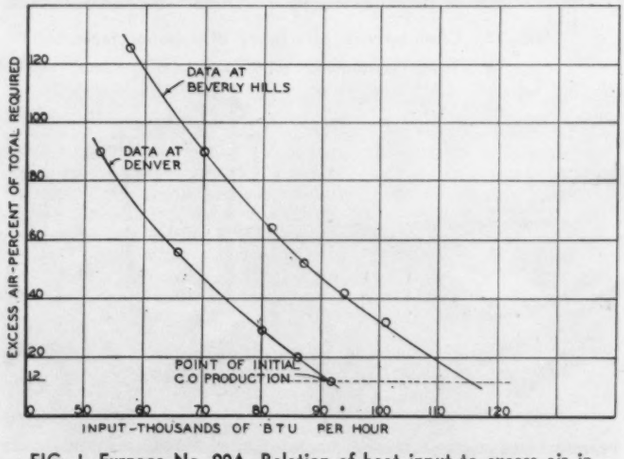


FIG. 1. Furnace No. 90A. Relation of heat input to excess air in combustion products at Denver and Beverly Hills.

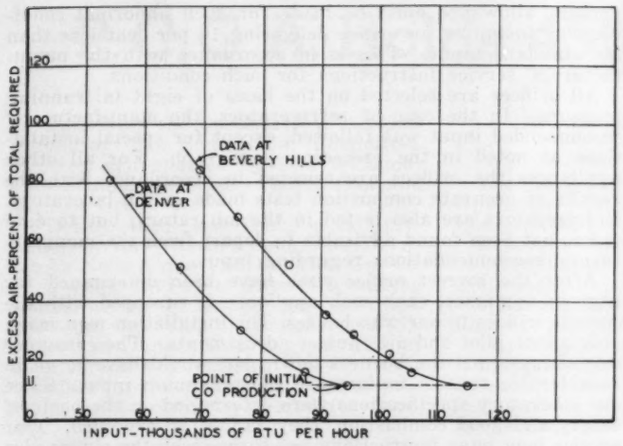

EXCESS AIR-PERCENT OF TOTAL REQUIRED
INPUT-THOUSANDS OF BTU PER HOUR
DATA AT BEVERLY HILLS
DATA AT DENVER
POINT OF INITIAL CO PRODUCTION

FIG. 2. Furnace No. 100 W.A.C. Relation of heat input to excess air in combustion products at Denver and Beverly Hills.

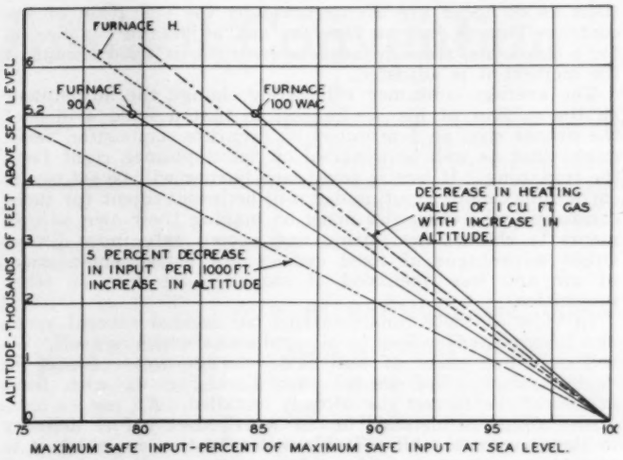

FURNACE H
FURNACE 90A
FURNACE 100 WAC
DECREASE IN HEATING VALUE OF 1 CU FT GAS WITH INCREASE IN ALTITUDE
5 PERCENT DECREASE IN INPUT PER 1000 FT. INCREASE IN ALTITUDE
ALTITUDE - THOUSANDS OF FEET ABOVE SEA LEVEL
MAXIMUM SAFE INPUT - PERCENT OF MAXIMUM SAFE INPUT AT SEA LEVEL.

FIG. 3. Heating value—per cent of heating value at sea level.

WAC are plotted as straight lines although determinations were made at only two altitudes.

Also included in Fig. 3 is a curve showing the A. G. A. recommended five per cent decrease in input per 1000 ft. increase in altitude, and another showing the decrease in heating value of one cu.ft. of gas with increase in altitude, computed from the relation:

$$V = V_o \frac{B}{B_o}$$

where

V = Heating Value at any given altitude
V_o = Heating Value at sea level
B = Barometric Pressure at which V is determined
B_o = Barometric Pressure at sea level

(B and B_o are taken from *Gas Engineers' Handbook*, first edition, 1934, Fig. 79.)

Input Reduction Recommended

From the data of Fig. 3 it is apparent that the A. G. A. stipulation of a five per cent decrease in heating value per 1000-ft. increase in elevation may be a little severe. On the other hand, the basis for reduction of input recommended by Eiseman, Smith, and Merritt, namely the consumption of the same number of cubic feet per hour of a given gas, regardless of altitude is found to provide the average necessary correction. This latter basis of input reduction has been adopted by many gas companies in the Rocky Mountain States by the stipulation that a gas furnace shall be adjusted to burn one cu. ft. of gas per hour for each thousand B.t.u. per hour of A.G.A. input rating. This is made possible by the fact that the heating value of gas served in these states is very close to 1000 B.t.u. per cu. ft. as measured at sea level.

Other Considerations May Affect Input Decrease

Any such arbitrary decrease in input with increase in altitude is based upon the assumption that combustion is the limiting factor in determining the normal heat input rate of an appliance. This is not necessarily true. Reference to Figs. 1 and 2 shows that furnace number 90 A, with a normal heat input of 90,000 B.t.u. per hour, was satisfactory from a combustion standpoint up to approximately 115,000 B.t.u. per hour at sea level, and that furnace number 100 WAC with a normal heat input rate of 100,000 B.t.u. per hour was satisfactory up to approximately 112,000 B.t.u. per hour. Other factors in determining this limit may be combustion chamber temperature, vent temperature, air discharge temperature, or the desire on the part of the designer to retain a margin of safety for high altitude operaton. Heating element, air discharge and vent temperatures, if affected at all by high altitude will probably not be increased. Spot readings taken during this series of tests on both furnaces, showed vent temperature rise to be consistently lower, at any given heat input, in Denver than in Beverly Hills, although variables other than altitude may have been responsible for this condition. Eiseman, Smith, and Merritt found the flue gas temperature for any given appliance to be almost entirely a function of the input rate, regardless of altitude.

With the addition to the A. G. A. approval requirements of restrictions to flue and air discharge temperatures, and with the increasing realization by manufacturers of heating equipment that the problem of satisfactory operation at high altitudes must be faced, it is probable that combustion will become less and less the prime factor in determining the normal heat input rate of furnaces. We may accordingly expect to find the necessary rate reduction on many furnaces to be much less than is indicated by a study of combustion effects alone.

For this reason utilities at high altitudes wishing to obtain the maximum safe gas burning rate from appliances which they sell should determine for themselves what this rate is for each model. Such a program is now under way in many localities. This program will, in addition to crediting the appliance manufacturer with any factor of safety he may have built into his appliances, actually promote the sale of gas burning equipment in competition with other fuels by lowering its initial cost to the consumer.

Experience with Fixed Orifices In Domestic Gas Appliances

By H. W. GEYER

Southern Counties Gas Company

THE gas served by the Southern Counties Gas Co. is 1100 B.t.u. natural gas, 0.65 specific gravity, and is distributed mostly at high pressure, with a house type pressure regulator at each meter. A small portion of the system operates at low distribution pressure, without individual house regulators. Lock-up or no-load pressure is held within eight to 11 in. water column at consumers' appliances on both systems, while running pressures are held within seven to nine inches, and seven to 10 in. at consumers' appliances served from high pressure and low pressure systems, respectively. With house type regulators in good condition, pressures approaching the lock-up limit do not occur on consumers' appliances while the appliances are in use; thus the actual running pressure on appliances can be held rather closely within the range of seven to nine in., averaging eight in.

With a variation of one inch in pressure from a base pressure of eight inches, the resulting change in gas flow will be only 6 per cent of the base volume. This is too small a variation to be of importance in the operation of any appliance, whether controlled manually or automatically. In the case of automatically controlled appliances, such pressure varia-

tions as do occur are counteracted by the operation of the control. This is just as true for an "adjustable" orifice as for a fixed one, since an adjustable orifice is fixed except at the moment it is adjusted.

The average consumer will rarely change the adjustment on the orifices of his appliances, so that a fixed orifice of the proper size, as determined by accurate combustion tests, might just as well be installed on the appliance right from the beginning. If this is done, each burner will be set to the correct maximum input, and it will be inconvenient for those consumers who otherwise insist on making their own adjustments to change the setting and exceed safe input limits. Other advantages of fixed orifices are better entrainment of air and less likelihood of stoppage by dust or other impurities.

In view of these considerations we decided several years ago to use fixed orifices in all appliances which we sell. We sell only one make of automatic storage water heater in various sizes. The heaters are furnished us with fixed orifices of the correct size already installed. All ranges have orifice adaptors installed in our warehouses before delivery to the consumer. All portable space heaters in which it is possible to mount an orifice adaptor are supplied with such adaptors. Up to the middle of 1936 we used individual gas pressure regulators on each gas refrigerator, but since then we have discontinued the use of such regulators.

A somewhat more detailed explanation of the reasons for abandoning the use of individual pressure regulators on refrigerators may be of interest. The manufacturer of gas refrigerators states that the gas input must be held within five per cent of the recommended value. This recommended value, however, is an arbitrary one, based upon estimated maximum room temperatures and heat dissipation from the unit with due regard to its location in the room, spacing from walls, etc. All gas refrigerators are under automatic control, however, and experience with automatically controlled appliances shows that such controls are well able to offset even relatively large pressure fluctuations. Moreover, it is possible to encounter variations in the heating value of natural gas of as much as five per cent during a year. Therefore, in view of the other possible variables, it seems reasonable that the unit could stand some variation in gas input without producing a change in its operation objectionable to the consumer.

Tests were made over a period of several months, both in the field and in the laboratory, throughout the entire range of room temperatures met with in our territory. These tests demonstrated conclusively that gas refrigerators could be operated directly on our standard gas pressures, without individual regulators. The field experience during the past two years has entirely justified our decision.

When boxes are closely built-in, restricting air circulation, or are installed in especially hot locations where the room temperature is likely to exceed 110° for comparatively long periods, allowance must be made for such abnormal conditions by installing an orifice delivering 10 per cent less than the standard input. This is in accordance with the manufacturers' service instructions for such conditions.

All orifices are selected on the basis of eight in. running pressure. In the case of refrigerators, the manufacturers' recommended input was followed, except for special installations as noted in the preceding paragraph. For all other appliances the orifices are selected in accordance with the results of accurate combustion tests made in the laboratory. Refrigerators are also tested in the laboratory, but to date it has not been found advisable to depart from the manufacturers' recommendations regarding input.

After the correct orifice sizes have been determined for a given appliance, each such appliance is equipped with the correct orifices in our warehouses. The installation men make only minor pilot and air shutter adjustments. The consumer can always turn the burners down, but would have to go to considerable trouble to increase the maximum input. Since our laboratory specifications were determined on the basis of safety and good combustion, they cannot be exceeded. Our service men have instructions not to increase the orifice size above that recommended by the laboratory.

Practical gas men often have a wide difference of opinion regarding the proper adjustment of a burner. We feel that such judgment is reliable only within rather broad limits, and when it is so easy to standardize inputs, and depend only on gaging of orifice sizes and water column pressure tests, there is no reason for substituting the variations of human judgment.

Appliance design and construction are undergoing rather rapid and radical changes. While it is true that there have been a number of consumers who are rather insistent upon getting the long billowing flames which they formerly had on their old appliances, we have been quite successful in pointing out to such consumers that the new appliances, properly adjusted according to their maximum rating, could give them higher efficiency, lower cost, and faster operation than their old appliances.

On the basis of our experience we believe the next logical step to be that of requesting the manuacturers of appliances, particularly gas ranges, to furnish all appliances sent to us and to dealers in the territory which we serve equipped with the correct size fixed orifices, delivered from the factory. Only pilot and air shutter adjustments should then be necessary. This move should be as welcome to manufacturers and independent dealers as it will be to us, as it greatly simplifies our mutual installation and service problems.

REFERENCES

"Effect of Fluctuating Service Pressure on Domestic Appliance Performance, and Appliance Regulators" by C. Eldon White and Charles W. Stewart, *P. C. G. A. Proceedings*, Vol. 28, 1937, p. 104-109.

"Resistance to Dust Stoppage of Various Types of Pilot Orifices" by Guy Corfield, *P. C. G. A. Proceedings*, Vol. 25, 1934, p. 146-149.

All-Year Club of Southern California Photo

Santa Barbara Mission garden is one of the treats in store for P.C.G.A. Convention delegates.

P. C. G. A. Holds 45th Annual Convention

"Satisfying the Customer," a skit presented by the Educational Committee. Written and enacted by Zita O'Connor and Eleanor Gemmell, Pacific Gas and Electric Co.

"It Happened Last Year," a skit presented by the Women's Committee. Written by Nelle Kinney, So. Counties Gas Co.

"Getting Into Hot Water," a talking motion picture of the London Gas Light and Coke Co. This picture features Mr. Therm who appears in a great deal of the company's advertising.

Following the completion of this program the floor will be cleared for dancing.

Breakfast table arrangement on Friday, Sept. 16, will be as on Thursday.

G. W. SMITH
Chairman, Convention Committee

R. G. LOGUE
Vice-Chairman Manufacturers' Section

GENERAL SESSION

SEPT. 16—9:30 A. M.—BALLROOM

Gas Industry Research—R. M. Conner, director of Appliance Testing Laboratories, American Gas Association.

Aspects of Regulation—E. F. McNaughton, director of Public Utilities Department, California Railroad Commission.

Reporting to Employees on Company Operations—William J. Barrett, manager Policy Holders Service Bureau, Metropolitan Life Insurance Co.

Public Utilities from the Sidelines—Lester S. Ready, consulting engineer.

Luncheon arrangements will be the same as on Wednesday and Thursday.

PARALLEL SESSIONS

MANUFACTURERS' SECTION

SEPT. 16—2:00 P. M.—LOWER LOUNGE

C. R. Graham, Chairman
James Graham Manufacturing Company

Address of Chairman.

Opportunities for Manufacturers—Norman R. McKee, president, Pacific Coast Gas Association.

When Sales Resistance Meets Eye Appeal—Dr. Walter Baermann, professor of Industrial Design, chairman of the Faculty and director California Graduate School of Design.

(Continued from Page 24)

The Need for Greater Uniformity in Appliance Guarantees—R. E. Fisher, vice president, Pacific Gas and Elec. Co.

Report of Nominating Committee—K. C. Tomlinson, Pacific Meter Works, chairman.

What the A.G.A.E.M. is Doing—H. N. Ramsey, president, Welsbach Co.

The Importance of the Appliance Manufacturer to the Gas Industry Sales Promotion—W. M. Jacobs, general superintendent of sales, Southern California Gas Co.

SALES and ADVERTISING SECTION

Norbert O. Fratt, General Chairman
Seattle Gas Company

COMMERCIAL and INDUSTRIAL SALES COMMITTEE

SEPT. 16—2:00 P. M.—ROOM 47

E. H. Adler, Chairman
San Diego Consolidated Gas and Electric Company

Economics of Commercial and Industrial Heating—R. W. Trowbridge, Seattle Gas Co.

Fats for Deep Drying—J. H. Gumz, Pacific Gas and Electric Co.

A Compact Low Temperature Air Heater—Chas. L. Ferry, Southern Counties Gas Co.

Manufacture of CO_2 from Natural Gas—A. F. Michael, So. Calif. Gas Co.

TECHNICAL SECTION

SEPT. 16—2:00 P. M.—UPPER DINING ROOM

A. B. Allyne, General Chairman
California Railroad Commission

Report of the Holder Maintenance Committee—A. F. Bridge, Southern Counties Gas Co., Chairman.

Report of the Research Committee—Guy Corfield, Southern California Gas Co., Chairman. A General Discussion of Technical Problems.

Concluding Remarks of the general chairman.

WOMEN'S COMMITTEE

SEPT. 16—200 P. M.—SHIP ROOM

Doris Allen, Chairman
Southern California Gas Company

Address of Chairman.

Industrial Education — Vivian Kirkpatrick, San Diego Consolidated Gas and Electric Co.

Individual Development—Lucy Rarey, Southern Counties Gas Co.

Advancing Friendly Public Relations—Freida Johnson, Seattle Gas Co. and Elsie Martin, So. Counties Gas Co.

Promoting Load Building — Esther Ladley Wright, Seattle Gas Co.

Value of Social Work—Zita O'Connor, Pacific Gas and Electric Co., Eleanor Hinch, San Joaquin Light and Power Corp., and Prudence Hury, Southern Counties Gas Co.

ANNUAL BANQUET and DANCE

SEPT. 16—FRIDAY EVENING

Coupons for the Banquet, received by those registering at the Convention Registration Desk, must be exchanged for Banquet Tickets not later than 9:30 a.m., Friday. All Banquet seats are reserved for ticket holders and table numbers will be assigned at the time tickets are given out.

CLIFFORD JOHNSTONE
Managing Director

DORIS ALLEN
Chairman, Women's Committee

LADIES' ENTERTAINMENT

Tickets for all Ladies' functions will be issued at time of registration at the P.C.G.A. Registration Desk.

SEPT. 14—2:00 P. M.

Buses leave the Biltmore for a tour of world-famous Montecito estates and gardens. Tea will be served in the Biltmore patio upon the return to the hotel about 4:00 p.m.

SEPT. 15—12:15 P. M.

Buses will leave the Biltmore for El Paseo Restaurant where luncheon will be served. Following luncheon there will be a sightseeing drive to Santa Barbara's old Mission, the queen of the missions, and to the Blaksley Botanical Gardens, returning to the hotel about 4:30 p.m. by way of the Santa Barbara's Riviera.

SEPT. 16—12:30 P. M.

Luncheon at Coral Casino followed by bridge.

MEN'S GOLF TOURNAMENT

The Annual Men's Golf Tournament will be played Saturday morning at La Cumbre Golf and Country Club starting at 9:00 a.m. Those who wish to compete should register not later than Friday noon. Entry blanks may be secured at the Registration Desk. Green fees will be $1.50.

Kansas-Minnesota Pipe Line Awaits R.F.C. Approval

THE Kansas Pipe Line & Gas Co., Chicago, Ill. has made preliminary application to the Reconstruction Finance Corp. at Washington for a $20,000,000 loan to finance construction of a natural gas transmission pipe line from the Hugoton Field, Stevens County, in southwestern Kansas to the Mesaba Range in northern Minnesota. The proposed pipe line upon completion would be approximately 850 miles long and would bring natural gas service to numerous communities in western Kansas, central Nebraska, eastern South Dakota and in Minnesota. An important purpose is to furnish fuel for the concentration or reduction of iron ores in the Mesaba Range.

L. E. Fischer, Chicago, is the president and principal stock holder in the pipe line company. The preliminary application of the company lists its address in care of John P. Devaney, Minneapolis attorney and former chief justice of the Minnesota supreme court.

A second pipe line project to bring natural gas to the Mesaba Range came a step nearer reality when application for a $42,500,000 loan from Reconstruction Finance Corp. was filed last July 6 by the Public Service Gas Co. of Montana, headed by John W. Schmidt and associates of Anoka, Minn. Purpose of this loan was to construct a gas transmission line from the Baker field in southeastern Montana through Bismarck, N. D. and into Minnesota and Wisconsin.

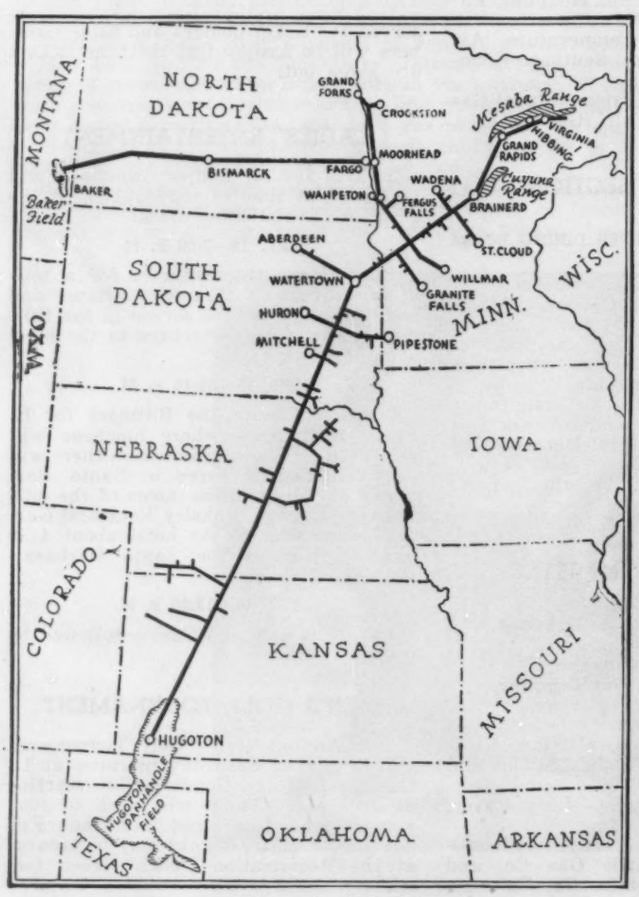
This application has been approved by Reconstruction Finance Corp. engineers, but is at the present time held up in the Examining department. Should the Reconstruction Finance Corp. fail to approve the $42,500,000 loan, plans have been formulated to construct a line from the Baker field to tie in with the Kansas Pipe Line and Gas Co. project at Fargo, N. D.

Regarding the Kansas to Minnesota project, it is estimated that the main transmission line will cost $12,675,000; tap lines, $3,500,000; compressor stations, $3,000,000. The right of way will cost approximately $1,000,000.

It is further estimated that the populations of the communities to be served by the line will exceed 375,000. In Nebraska the proposed lines would serve 32 towns totalling 47,000 people; in South Dakota, 84,000 people in 33 towns. The 53 Minnesota communities to be served have a population in excess of 180,000.

Considered by many to be the most important aspect of the project is the use of gas for the conentration and reduction of iron in the Mesaba Range.It is estimated that there are one billion tons of high grade direct shipping ore left in Minnesota. This is an average supply for approximately 30 years, dependent to a great extent upon the future use of iron and steel. In order to secure one ton of useable iron ore, about three tons of lower grade material may be used. Low power costs are essential in handling this weight material.

If the Kansas Pipe Line and Gas Co. application for a $20,000,000 loan is approved, 100 new wells will be drilled in the southwestern Kansas and Oklahoma panhandle to supply the proposed transmission line.



Map of the proposed transmission line projects which will carry natural gas from fields in Montana and Kansas to northern Minnesota.

Burt Bay is Vice-President of Northern Natural Gas Co.

Burt R. Bay, of Kansas City, Mo., on August 1, assumed his new duties as executive vice-president of the Northern Natural Gas Co., Omaha, Neb. Mr. Bay has resigned from his former post as vice-president and general manager with the Panhandle Eastern Pipe Line Co.

BURT R. BAY

Actively associated with the natural gas industry for more than 30 years, Mr. Bay was connected with the natural gas subsidiaries of the Cities Service Co., chiefly in the Empire Gas and Fuel Co. group, for more than 15 years, and in 1929 was appointed vice-president and general manager of Missouri-Kansas Pipe Line Co., then operating in Kansas City, Mo. Shortly after Mr. Bay's appointment, the Missouri-Kansas Co. organized the Panhandle Eastern Pipe Line Co. with which Mr. Bay has been associated until his recent appointment.

Consolidated Gas Utilities Elects Hirschfield, Joullian

Norman Hirschfield, New York City, was elected vice president of the Consolidated Gas Utilities Corp., Oklahoma City, Okla., at a recent meeting of the board of directors. Before coming to Oklahoma he was indirectly connected with the Arthur M. Lamport Co., of New York.

At the same meeting E. C. Joullian, Oklahoma City, was made executive vice president of the corporation. He was formerly vice president. Arthur M. Lamport, New York City, was elected chairman of the board.

The presidency of the corporation made vacant by the death in July of Logan W. Cary remains unfilled.

Michigan Town Seeks Gas

Sheridan, Michigan has granted a 20-year natural gas franchise to Edward C. Dailey.

Wallace Heads W. Va. Oil and Natural Gas Association

HARRY A. WALLACE, JR., president United Fuel Gas Co., Charleston, W. Va., was elected president of the West Virginia Oil and Natural Gas Association at the final session of the organization's annual convention, held July 27-28 in Charleston. Mr. Wallace succeeds Dan S. Keenan, vice-president, Carnegie Natural Gas Co., Pittsburgh.

Other officers named were W. P. Kerwood, Jr., of St. Marys, W. Va., vice-president, and Edwin Robinson, of Fairmont, W. Va., who was reelected secretary-treasurer. Twelve directors were also chosen.

More than 600 producers, technicians, and field men attended the two-day meeting of the association. Convention speakers for the opening session included William A. Dougherty, counsel, Standard Oil Company of New Jersey, who discussed the increasing governmental control of the oil and gas industry; H. S. Brubaker, manager of oil and gas industry sales, Monongahela West Penn Public Service Co., who spoke on electricity in the oil and gas industry.

The closing event of the first day of the convention was the annual banquet at which Sam W. Meals, president, Carnegie Natural Gas Co., was toastmaster. Among the speakers at the closing session was J. French Robinson, president, Peoples Natural Gas Co., Pittsburgh.

■ ■

W. J. Morgan of East Ohio Co. To Retire September 30

William J. Morgan, manager of the Canton office of the East Ohio Gas Co., Cleveland, will retire September 30, after 40 years service with the company. Terry W. Brown, manager of the company's Massillon office, will succeed Mr. Morgan.

Mr. Morgan began his career with East Ohio in New Philadelphia where he helped to organize gas service in that community.

Incident to Mr. Morgan's retirement is the announcement by East Ohio officials of the transfer of other company agents. Replacing Mr. Brown in Massillon will be J. E. Ryan, for 16 years agent at the Barberton office. At Barberton C. E. Warner, now at Cuyahoga Falls, will be in charge, and L. E. Seeds, now a supervisor in the Akron office will take Mr. Warner's post.

■ ■

G. J. Neuner Has New Position with Panhandle Eastern Co.

G. J. Neuner, formerly vice-president and counsel of Panhandle Eastern Pipe Line Co., Kansas City, Mo., was elected to the position of vice-president in charge of operations by the board of directors of the company at a meeting on July 20. Actively identified with the oil and gas industry for more than 20 years, Mr. Neuner succeeds Burt R. Bay who recently resigned.

■ ■

A. V. Grief of Gary, Ind., Dies

A. V. Grief, vice-president and general manager of the Gary Heat, Light and Water Co., Ind., died August 16. Mr. Grief, who was 39 years of age, had lived in Indiana for three years.

FIG. 1. Three 10 by 6 by 10 duplex pumps arranged for 1000-lb. line test, with high pressure gas line at right and across power ends of pumps.

Natural Gas Used to Power Pipe Line Test Pumps

By ELTON STERRETT

Longview, Texas

AN UNUSUAL application of gas for power occurred in connection with the acceptance tests on a crude oil main line in East Texas; where, as usual on pipe line jobs, the station pumping equipment was not available for the filling of the line with water and the imposing of the 1000-lb. test pressure specified. To fill the line alone, 790,000 gals. of water were required, this to be picked up from a nearby creek.

The pump installation (see. Fig. 1) for this test consisted of three 10 by 6 by 10 duplex steam pumps, with a working pressure of 375 lbs. each, arranged through simple manifolding of inlet and discharge lines so the three could be used in parallel for filling the line, and then tied in in series to boost the ultimate line pressure against a closed gate on the pipeline delivery end to the specified 1000 lbs. per sq. in.

Original plans called for the temporary installation of the necessary oil field boilers, or "pots," to generate the steam for these three pumps, fuel for the boilers to be drawn from a nearby high-pressure gas main, carrying natural gas from the Louisiana fields westward toward Dallas and Fort Worth.

Before the boilers could be secured against the competition for steam generating equipment put up by drilling contractors at the time, it was found that the line pressure in the 16-in. gas main was 375 lbs. per sq. in., and the four-inch branch originally tied in to bring gas to the boiler regulators was carried directly to the pump bank, as shown in "G" of Fig. 2. This high pressure gas was then used directly in the power end of the duplex pumps, through the normal valve arrangement and a series of individual or unit valves as "g".

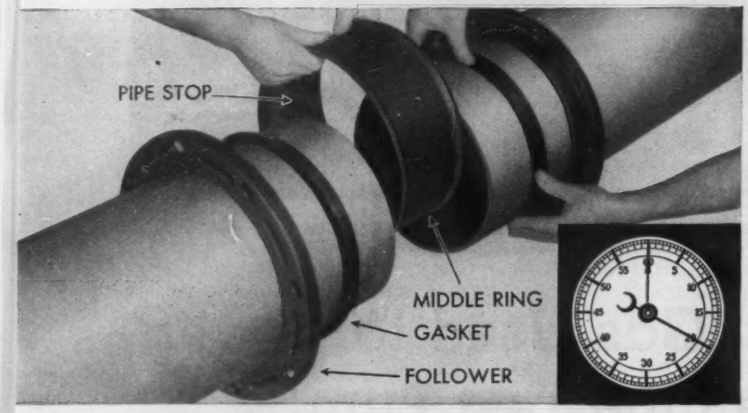
This high pressure gas was delivered to the (normally) steam pistons at a higher pressure than could have been derived from boiler-made steam, presented no condensation problems, and offered immediate power for the testing.

When the three pumps were used for filling the line, each pump worked as a unit, picking up water through its own suction and discharging through the proper valve into the common main "M", which tied in, through a double swing, with the pipe line.

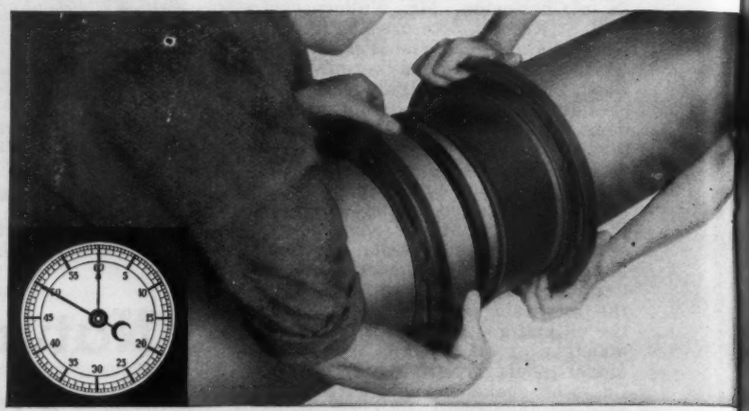
As the line filled and pressures rose to the maximum delivered by any one unit, the compounding valves were manipulated and the water handled through each pump in turn, No. 1 picking up from the creek, No. 2 taking the discharge from No. 1 and boosting it to 700 lbs. pressure, while No. 3 took this high-pressure water and put the desired 1,000 lbs. pressure against it.

The high-pressure gas from the main, being an elastic source of power, automatically swung pumps

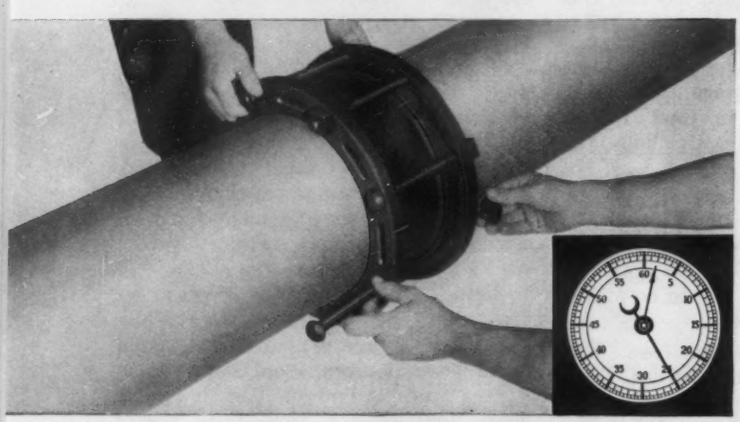
SPEED UP*



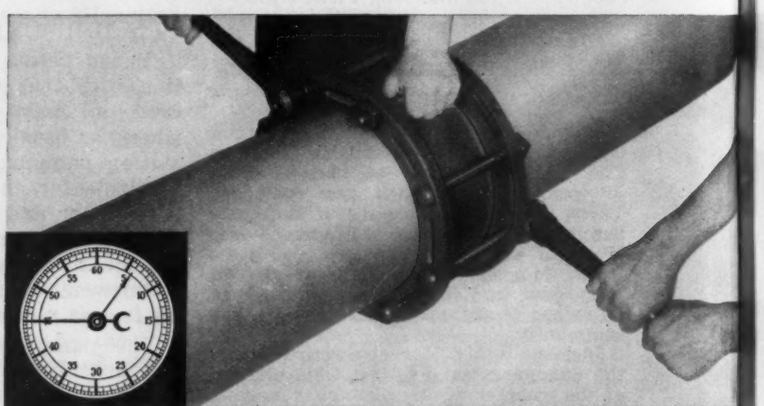
20 SECONDS—STEP 1! Dresser followers and gaskets have been placed over plain-end pipe (12" ID). Middle ring goes on next; note inside pipe-stop. With Dressers, no time is lost due to tedious lining-up of pipe-ends or other complicated "getting-ready" steps.



AT 50 SECONDS—STEP 2! Pipe-ends have been shoved "home" against middle-ring pipe-stop; gaskets and followers are then brought up. With Dressers, no one step holds up others. No workmen interfere with one another. Each has full-time job. No delays getting tests.



AT 2 MINUTES, 25 SECONDS—STEP 3! Bolts are inserted and nuts run up finger-tight. With Dressers, the small, well-bunched crew is always "up" with ditcher (reducing supervision problems). No "lag" between laying and jointing. No long trench length need be kept open.



AT 6 MINUTES, 45 SECONDS—FINAL STEP 4! Nuts are wrenched up tight. Jointing with Dressers is quickest part of job—can be done only in one way, i.e., permanently tight the first attempt every time! Flexibility gives top speed with straight pipe on many curves.

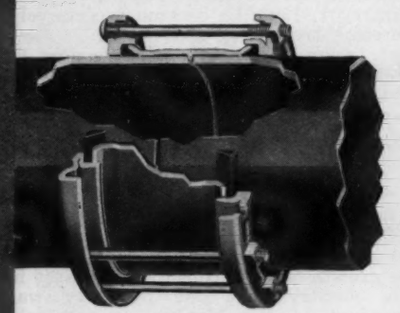
5.2 MILES IN 11 HOURS! That was the record set on this Dresser-coupled 5½" OD line in Texas. Assembly with Dressers is "straight-line"—economical from several points, *enabling additional labor to be added easily*. Wet ditches, rain, snow, muck, wind, swamps, even darkness, etc., cannot seriously retard progress.

LOCATION	SIZE OF LINE	RECORD	REMARKS
Southwest Texas	5½-in. OD	5.2 miles in 11 hrs.	Dawn-to-dusk. "Green" labor used.
Auburn, N.Y.	10-in. ID	4,640 ft. in one day	Going toughest in 13 states. Swamps, quicksand, and water.
Ontario, Canada	10-in. ID	52 miles in 50 days	Undulating terrain. Line completely buried without pressure test.
Cincinnati, Ohio	12-in. CIP	1,312 ft. in 9½ hrs.	Cast-iron pipe and couplings, requiring care in handling and lowering.
Buffalo, N.Y.	36-in. ID	680 ft. in 8 hrs.	First day's work by gang of "pick-up" relief labor, totally unfamiliar with pipe laying.
Ft. Wayne, Ind.	42-in. ID	400 ft. in 8 hrs.	Laying crew of only 10 men had to wait for trencher on almost every pipe length.
Birmingham, Ala.	60-in. ID	3,040 ft. in 8 hrs.	WPA labor; includes all work except small part of backfilling, and testing.

TYPICAL SPEED RECORDS. See Table above. Assembly time per Dresser joint may be safely estimated as follows: 4": 3 min; 6" & 8": 5 min; 10" & 12": 7 min; 14": 8 min; 18": 10 min; 20": 12 min; 24": 14 min. (Two boltmen—all jointing operations after stringing. Based on time studies. For other sizes, figure 2 man-minutes per bolt).

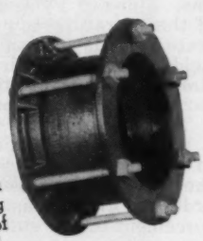
Your Pipe-jointing!

(Cutaway view of Dresser Coupling, Style 38)



* SPEED . . . .YES! ALSO:

1. PERMANENT TIGHTNESS—proved for 50 years, on 150,000 miles of pipe.
2. FLEXIBILITY—expansion, ground movements, vibration, lowering stresses, etc., are absorbed. Many curves, grades, etc., made with straight pipe.
3. SIMPLICITY—standard parts are assembled on plain-end pipe by unskilled labor, using only a wrench under almost any weather or ditch conditions.
4. STRENGTH—predetermined; joints safely withstand any specified pressure.
5. TRUE ECONOMY—a truly lower joint cost throughout life of line, plus salvage.



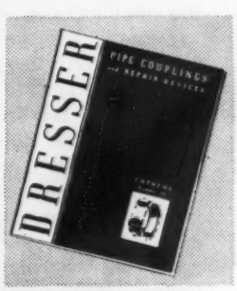
For joining cast-iron pipe, Dresser Cast Couplings, Style 53, are also available. Approximately same as Steel Coupling, Style 33, in corresponding sizes, except of cast material. Bolts are galvanized steel or cast. Employ same working principle as shown in cutaway view above.

When your plans are all made—when an absolute dead-line or time penalties have been set—when the pipe line must be completed on schedule to get revenue started or to avoid delaying other parts of the project—then you want a joint that *won't hold you up*—despite rain, snow, swamps, etc.

With "pace-setting" Dresser joints, you are *certain* of getting your line in as fast as you want.

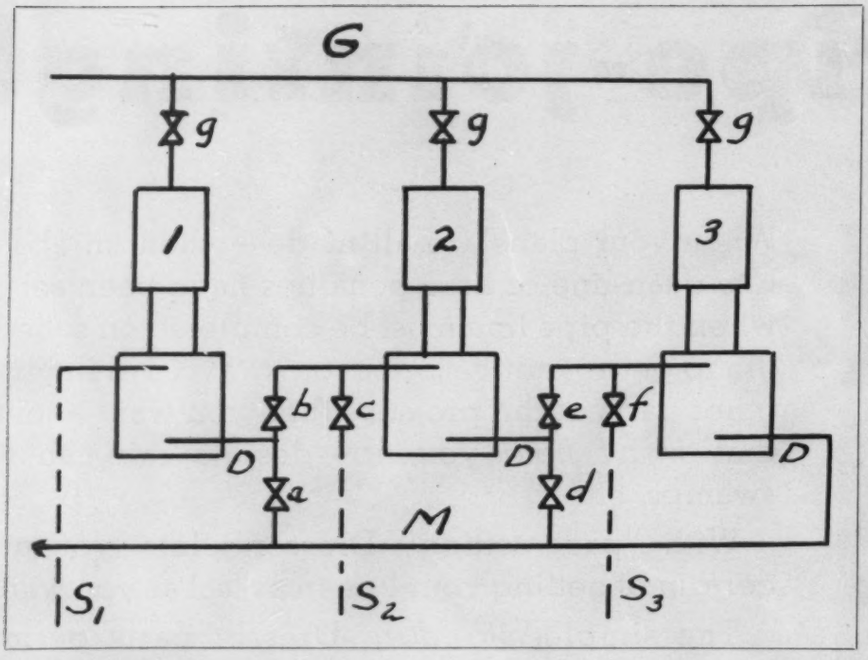
The simple, *standard* Dresser parts permit smooth, steady, uniform speed—faster than the ditcher itself can travel—with no lost motion. No single, slow operation sets up a "bottleneck." Everything is coordinated—moves forward in unison like clock-work. Assembly both above the ditch (safe and practical *only* with flexible Dressers) or in the ditch is *measurably* speeded up.

Results: The length of line laid in a day is the actual length *completed.* Faster installation sharply reduces direct costs, overhead, and interest during construction. And all with the use of unskilled labor—plus joint tightness and flexibility proved for 50 years!



For further details, write for our General Catalog No. 36, a virtual handbook on pipe joints. ● S. R. DRESSER MFG. CO., BRADFORD, PA. *New York:* 17 East 42nd Street; *Chicago:* Peoples Gas Building; *Houston:* Shell Building; *San Francisco:* 1038 Polk Street; *In Canada:* Dresser Mfg. Co., Ltd., 60 Front Street, West, Toronto, Ontario.

DRESSER
PIPE COUPLINGS



1, 2, 3,—Duplex pumps.
S, S, S,—suction lines.
D, D, D,—discharge lines.
M—4-in. discharge line.
a, d,—discharge gates.
b, e,—compounding gates.
c, f,—intake gates.
g, g, g,—gas gates.

Diagram of pumps, suction and discharge lines, and high pressure gas line for pipe line testing.

2 and 3 into step behind No. 1 when compounded, each stroking accurately behind the discharge of the one preceding.

The exhaust gas from each pump was carried out through a 40-ft. lead to a spot above the creek, and there ignited. During the main exhaust of the stroke the flames were from 20 to 40 ft. in length, dying down to a foot-long stub during stroke reversals, but maintaining flare enough to ignite the next exhaust impulse.

Despite the heat of the exhaust flares, all but the final two ft. of the two-in. exhaust lines were sheathed in ice from the onset of the pumping test until the power was cut off at the successful close of the run.

Comparative costs of the use of the gas, as used expansively in the power ends of the pumps, as computed against probable gas consumption under the boilers which otherwise would have been required, showed a slight increase in power cost—a margin more than compensated for by the speed with which the test was run, and by the saving on boiler rental and equally high costs of transportation of steam generating equipment to and from the site of the test.

The duration of the test was such that, using gas as power, no lubrication was required in the power ends of the pumps; though, had a long run been demanded, some type of force-feed lubrication would have been installed, provision for such being made during the preliminary piping at an inlet into the gas main just before the branch leading to the first of the three pumps.

■ ■

Moving of Gas Mains Nears Completion in Cincinnati

The Cincinnati Gas and Electric Co.'s eight-year project of moving the company's Columbia Ave. gas mains and distribution facilities in order that the arterial driveway could go through is now nearing completion. The major task of the $200,000 project was the moving of a mile of 30-in. main, the largest pipe used in the local gas system. Through last winter and up to a month ago three crews of workmen were required for the job.

The last step of the Columbia avenue construction is the installation of a district regulator at Kemper lane, a replacement necessitated by construction work on the boulevard. In all, there are 65 of these district regulators in operation in the local system.

■ ■

Submarine Gas Pipe Line Completed in Alabama

At an approximate cost of $12,000, a new independent submarine gas line extending directly from Sheffield to Florence, Ala., has recently been completed, according to an announcement by W. S. Eastep, president of the National Utilities Co. of Florence and of the Twin Cities Gas Co., Sheffield, Ala. The new line is four miles long.

Fred A. Miller, Dresser Official, Dies August 22

FRED A. MILLER, Honorary Board Chairman of S. R. Dresser Manufacturing Co., Bradford, Pa., died August 22, at Beechwood, his home in Bradford. Death was attributable to a heart ailment. Seventy years of age, he had been in failing health for several months.

A prominent figure in the growth of the gas industry, Mr. Miller was for 35 years associated with S. R. Dresser Manufacturing Co., manufacturer of pipe couplings for gas lines. Joining Dresser January 1, 1903, he became successively secretary-treasurer, and in 1911, president, upon the death of Solomon R. Dresser, the original founder of the company in 1880. In 1929, Mr. Miller was made chairman of the Board of Directors, from which position he resigned May 27, 1938, on his 70th birthday. The directors later named him Honorary Chairman in recognition of his valuable services to the company.

Born May 27, 1868, Mr. Miller took a prominent part during his lifetime in the growth of the natural gas industry in this country. At one time, he was president of the Natural Gas Supply Men's Association and later a director of the American Gas Association.

Shortly before his death, Mr. Miller was presented with a silver memorial scroll, given to him by his friends and associates in the Dresser Co. "in tribute to his sterling character, high principles, eminent leadership, and devotion to the Dresser Company."

■ ■

Gas Conservation Program Begun in California

To curb the excessive production of natural gas in California, the state Division of Oil and Gas has begun a gas conservation movement. The program began June 28 with a meeting of operators of the Dominguez field who agreed to work out a plan to prevent future wastage of gas. Howard Pyle was named chairman of the operators' committee to work with state officials to establish a new ratio in fields exceeding their gas quota. At that time a series of meetings was planned to carry out a definite program.

The new program is the outgrowth of a mass meeting called by the governor of the state, Frank F. Merriam, to bring the matter of gas wastage to a head in order to avoid drastic steps toward enforcement of the state's gas act.

■ ■

A.G.A. Booklet Describes "Easiest-to-Keep House"

Offered by the American Gas Association in the 1937-38 series of national ads is the booklet, "Planning the World's Easiest-to-Keep House," by Constance Holland. In the 23-page illustrated booklet Mrs. Holland shows that the home in which gas does the four big jobs is the "easiest-to-keep house." Narrative in form, the booklet is designed for local distribution.

■ ■

Bailey Van Ness Emery Dies

Bailey Van Ness Emery, secretary-treasurer of the Dixie Oil and Gas Co., died July 20, in a Tulsa hospital, following a two-week illness.

Cp WEDGEWOOD Wins New Friends For Gas

Better in 22 Ways

TEA FOR TWO or DINNER FOR TWENTY

Six - Burner Cooking Top. Giant and Standard Speed-plus-Simmer Burners for greatest flexibility in cooking.

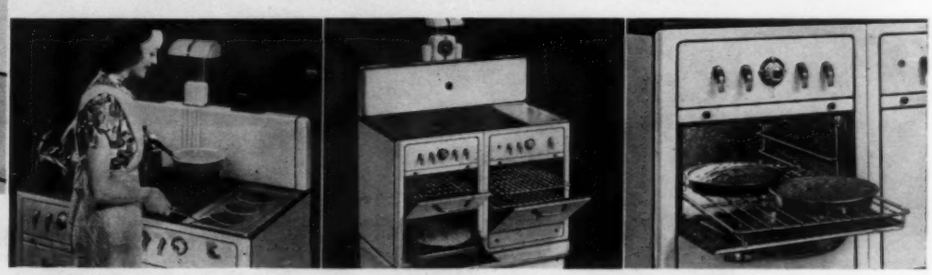
SPECTACULAR NEW Cp WEDGEWOOD RANGE HAS MANY PLUS SALE FEATURES!

- Flush-to-Wall Construction
- Recessed Solid Base
- Folding Cover-Top
- Smartly Styled Lamp and Clock
- Distinctive Hardware Styling
- Streamline Backguard and Vent
- 3-Section Porcelain Enamel Top
- Separate Pastry and Baking Ovens
- 6-Burner Open or Closed Cooking Top
- Removable Aluminum Griddle
- Speed-Plus-Simmer Burners
- Super-Speed Giant Burners
- Hi-Speed Low Temperature Oven
- Astogril Broiler

Uses natural, manufactured or bottled gas.

3 SECTION TOP . . . EASY TO CLEAN

The top is designed in 3 sections so that each can be easily removed for cleaning.



GOLDEN BROWN HOTCAKES . . . IN A JIFFY!

You don't have to be a master juggler to turn hotcakes on the new Wedgewood griddle! Easy to use . . . easy to clean. Light weight. Removable.

TURKEY IN ONE OVEN . . .

Every woman has wished for two ovens when company comes! This Wedgewood has separate roasting and baking ovens, yet the new range is no larger than present models!

MINCE PIE IN THE OTHER!

The Main Oven is EXTRA big—18" wide by 14" high by 20" deep. Pastry Oven 10" x 8" x 20". High Speed-Low-Temperature Burners in each oven light themselves . . . no matches.

WEDGEWOOD

THE MODERN GAS RANGE

MORE THAN A MILLION SATISFIED USERS

JAMES GRAHAM MANUFACTURING CO. • SAN FRANCISCO, LOS ANGELES, NEWARK, CALIF.; PORTLAND, ORE.

Two big for Installing WARD FLOOR

They are PERMANENT

Permanence is a mighty important word to you as a gas company merchandiser. It makes your selling job easier. Once you install a WARD FLOOR FURNACE you have an able ally . . . an efficient "salesman" . . . working for you in that home from now on. A WARD becomes a permanent part of the house. It stays put. It can be depended on to build and protect your load for a long, long time. Guaranteed for ten years . . . built for a lifetime.

THE PICTURE AT THE LEFT

. . . illustrates how a WARD FLOOR FURNACE hangs beneath the floor, taking no room space. It suggests, too, how compact and complete this furnace is. All controls and accessories are built in. That makes installation easy. No basement is necessary. No wires to run. No fragile connections. Just drop the furnace into the floor opening . . . connect to vent and gas line . . . and it is ready to go to work. It can be installed, without muss or dirt, in less than half a day.

YOUR LOAD IS AS GOOD AS THE APPLIANCE YOU SELL

Reasons FURNACES on Your Lines

They are AUTOMATIC

Your customers judge the desirability of gas for heat by the performance of the appliance you sell them. That's why we always say "your load is as good as the appliance you sell." An automatic WARD FLOOR FURNACE ... with its Bilt-in Thermo-Control and Safety Pilot ... regulates temperature accurately ... uses fuel economically, protects the home positively. That's why WARDS have done such a swell job for so many utilities ... and can do the same for you.

THERE IS PROFIT IN WARD FURNACES For AUXILIARY HEAT

Don't overlook this opportunity. WARD FLOOR FURNACES not only provide major warmth for hundreds of thousands of homes ... but also are ideal for auxiliary heating in a great many places. For rooms that are used a lot ... for hard-to-warm spots ... for use in fall and spring when basement furnaces are not turned on. This auxiliary heating service with WARD FLOOR FURNACES can get you into many homes, one-story stores and offices that should be making greater use of your fuel. The uses of WARDS are so diverse that you will find them a most profitable appliance to handle.

Write for our latest catalog, price lists and complete details.

WARD HEATER COMPANY

LOS ANGELES, CALIFORNIA

REPRESENTATIVES

J. H. STUBBINS	W. D. ROBERTS	A. S. KINCAID	H. C. SANDERSON	J. N. DOYLE
300 East 68th Terrace	468 Peoples Gas Bldg.	2012 North Harwood	207 Fulton Building	1827 Forest
Kansas City, Missouri	Chicago, Illinois	Dallas, Texas	Pittsburgh, Pennsylvania	Denver, Colorado

. SELL THE BEST . . . SELL WARD FLOOR FURNACES

The birth of the "CP" gas range was heralded by this Wisconsin Public Service Co. window display.

Wisconsin Co. Installs "CP" Range Educational Course

WITH the introduction of the "CP" gas ranges, sales executives of Wisconsin Public Service Corp., Green Bay, Wis., planned an educational program to acquaint not only sales people, but the employees of other departments and the dealers on the possibilities of this promotion. First step in this program was a meeting of the entire sales force at Two Rivers in July where "CP" ranges were hooked up and demonstrated. The 22 points of superiority were presented and explained, and the plan of promotion was outlined in detail. Samples of newspaper advertising were available and a schedule of advertising was outlined to representatives present.

The next step in education was a series of meetings conducted for employees. At these meetings a summary of the "CP" gas range and its advantages was presented. This was told to over 300 employees in a series of 17 meetings. It was realized that a large group of employees could not attend these meetings, and C. R. Phenicie, vice president of sales, issued a letter to all employees telling them in detail of this promotion.

The third step was a series of dinner meetings for dealers held in each division. The "CP" promotion was presented, a copy of the A.G.A. chart being used to show what the "CP" range was and what was being done nationally to promote the sale of same. The dealers also were told of the coming "CP" gas range sale and Old Stove Round-Up which was scheduled to start late in August. A set of window cards was given to each dealer. Eighty-eight dealers attended these five divisional meetings, and these represented about 90 per cent of the volume of gas range business done in the area.

In addition to this educational work, company display windows were used to good advantage. Approximately a week prior to August 1, one of the windows in the office was blocked off. This window carried the lettering "Watch this window for important announcement, approximately August 1st." A picture of a stork was used.

On August 1 the window was unveiled displaying a beautiful "CP" gas range with the "CP" range requirements. (See cut).

CALENDAR

September, 1938

Maryland Utilities Association—Fall Convention, George Washington Hotel, Ocean City, Md., September 9-10.

Pacific Coast Gas Association—45th Annual Convention, Santa Barbara Biltmore Hotel, Santa Barbara, Calif., Sept. 14-16.

National Petroleum Association — 36th Annual Meeting, Hotel Traymore, Atlantic City, N. J., September 14-16.

Empire State Gas and Electric Association — Annual Convention, Lake Placid Club, Lake Placid, N. Y., September 15-16.

Liquefied Petroleum Gas Association, Midwest Section—Semi-annual Fall Meeting, Hotel Bismarck, Chicago, Ill., September 22-23.

Oklahoma Utilities Association, Gas Division—Oklahoma City, Okla., September 26.

Public Utilities Association of West Virginia—20th Annual Convention, The Greenbrier Hotel, White Sulphur Springs, W. Va., September 30-October 1.

October, 1938

A. G. A. Twentieth Annual Convention—Atlantic City, N. J., October 10-13.

National Hotel Exposition*—Grand Central Palace, New York, N. Y., Oct. 24-28.

National Metal Congress and Exposition*—Detroit, Mich., October 24-28.

November, 1938

The Institute of Gas Engineers—London, England, November 1-2.

American Petroleum Institute—19th Annual Meeting, Stevens Hotel, Chicago, Ill., November 14-18.

December, 1938

National Exposition of Power and Mechanical Engineering*—Grand Central Palace, New York, N. Y., December 5-10.

* Includes exhibit sponsored by A.G.A. Industrial Gas Section.

Directory of Gas Distributing Companies is Published

THE Association of Gas Appliance and Equipment Manufacturers is now supplying members with a complete, yet simplified, listing of all gas distributing companies operating in the United States. This compilation, classified according to states, includes the names of all the companies supplying gas service, their principal offices, the total number of customers served by each, the kind and heating value of gas served.

An introductory classification gives number of gas companies operating in each state and their total customers. A new practical feature is the providing of a blank column on each page of listed companies for the use of the manufacturer.

Two supplements list the gas distributing companies in Canada and the holding and managing companies in the United States.

Dr. A. E. Schuh Fills U. S. Pipe and Foundry Research Post

The United States Pipe and Foundry Co., Burlington, N. J., has announced the appointment of Dr. Arthur E. Schuh as director of research.

Dr. Schuh received his B. S. and Ph.D. degrees from the University of Chicago, specializing in physical chemistry. Since 1929 he has been associated with the Bell Telephone Laboratories, New York, as physical chemist. Previously he was connected with the Western Electric Co., Chicago.

Dr. Schuh is an active member of the American Society for Testing Materials and the American Chemical Society and is the author of many technical papers on organic coatings, finishes and protective coatings for metals.

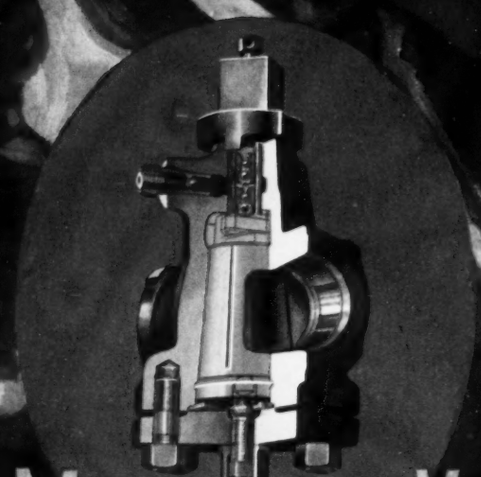
Herty Has New Appointment With Brooklyn Union Gas

Frank B. Herty has recently been appointed industrial sales manager of the New Business Department of the Brooklyn Union Gas Co. Mr. Herty, who had been supervisor of retail sales since April, 1934, succeeds Robert H. Staniford, who resigned. James J. Deely, formerly supervisor of the house heating division, succeeded Mr. Herty as retail sales supervisor.

Pa. Has New Deep Gas Well

The Peoples Gas Co. recently brought in a heavy flow of gas under 2500 lbs. pressure at 7656 ft. near Greenburg, Westmoreland county, Pa.

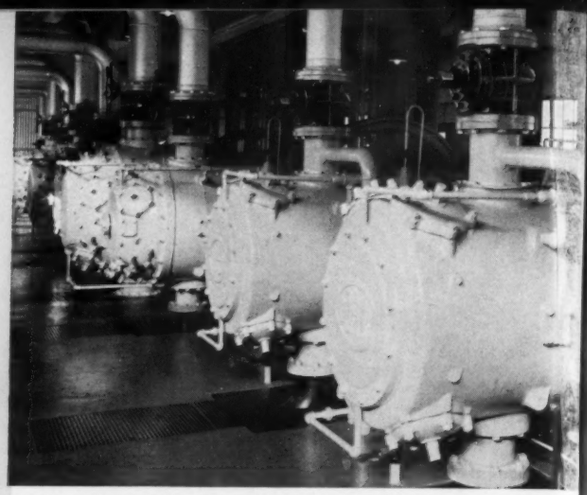
FOR VOLCANOES OF
PRESSURE AND TEMPERATURE



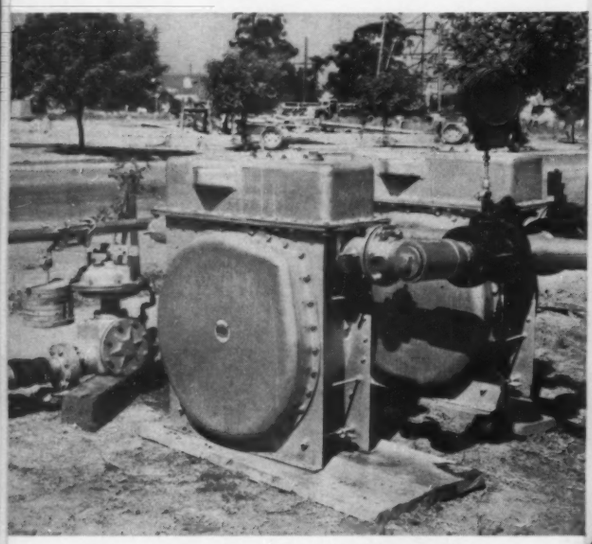
NORDSTROM HYPRESEAL VALVES

MORE *and* MORE, NORDSTROM *Lubricated* VALVES *Predominate on* GAS LINES

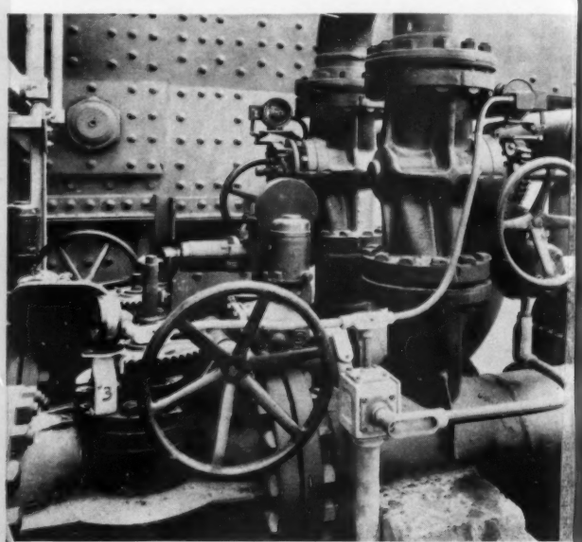
Nordstrom gear-operated Valves at metering, regulating and odorizing control station.



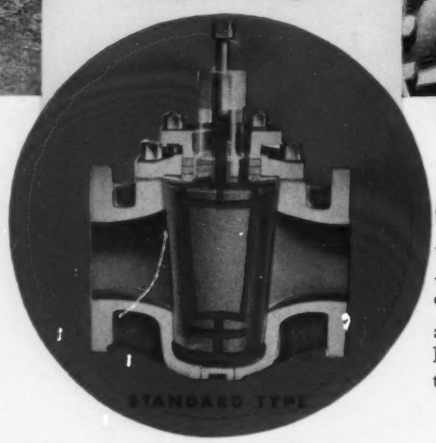
Nordstrom Valves on intake and discharge lines on gas compressors in an Oklahoma pumping station.



Emco No. 5 Meter, Emco Regulator and Nordstrom Valves on natural gas line.



Nordstrom Valves on gas transmission line equipped with remote control.



Sealed against leakage

Gas lines are held tight, without a trace of a leak with Nordstroms. These valves are as essential on low-pressure city distribution lines as on high-pressure transmission lines.

Quick closure — quarter-turn

You can tell at a glance whether the valves are open or closed. No fear of a "frozen" valve when infrequently operated. The plug is always easy to turn. Patented "Sealdport" lubrication guards the valve.

PRODUCTS—NORDSTROM VALVES; EMCO GAS METERS and REGULATORS; PITTSBURGH LIQUID METERS

MERCO NORDSTROM VALVE CO. *A Subsidiary of* **PITTSBURGH EQUITABLE METER CO.**

MAIN OFFICE: Pittsburgh, Pa. • BRANCH OFFICES: New York City, Buffalo, Philadelphia, Columbia, Memphis, Chicago, Kansas City, Des Moines, Tulsa, Houston, Los Angeles, Oakland. • CANADIAN LICENSEES: Peacock Brothers, Ltd., Montreal. • EUROPEAN LICENSEES: Audley Engineering Co., Ltd., Newport, Shropshire, England.

NORDSTROM VALVES

WITH PATENTED "SEALDPORT" LUBRICATION

Only Nordstroms meet every major valve need

Galveston Gas Men Fight Sea To Continue Gas Service

THE Texas Cities Gas Co. fought a winning battle against the sea in order to insure continuous gas service to Galveston consumers while the company replaced more than 8000 ft. of its two eight-in. main lines in Galveston Bay during July. The project was the largest marine pipe line laying job undertaken by the company since the laying of the original two miles of eight-in. dual lines in the bay in 1928 and 1929.

The finished job gives the company one complete cast iron main line in the bay between the island and mainland, approximately two miles. Each cast iron joint was 16 ft. long and weighed 800 lbs. These were made into eight joint lengths on a pier and towed out to position on specially constructed 128 ft. pontoons. A company designed marine pipe line laying barge enabled workmen to connect the 128 ft. lengths to the bay line which was then cut loose from the pontoons and lowered into the bay as each section was connected up. The barge kept the open end above water until the next section was towed into place and bolted on.

■ ■

F. E. Seaver, W. P. Hand Named to So. Cal. Gas Posts

The position of secretary of the Southern California Gas Co., left vacant by the retirement of Charles L. Whitehill,

W. P. HAND

F. E. SEAVER

will be filled by Fred E. Seaver, assistant secretary of the company, according to an announcement of A. B. Macbeth, president of the company. Seaver served as secretary of the Los Angeles Gas and Electric Corp. before the merger of that company with So. California Gas Co.

At the same time, appointment of W. P. Hand to succeed Henry C. McAllister as manager of the company's eastern division, was confirmed. Mr. Hand, formerly district agent in San Bernardino, was appointed assistant division manager in May. He has been with the company for the last 12 years.

■ ■

British Manufacturer to Attend A.G.A. Convention

R. G. Gibbons, works manager, W. C. Holmes and Co., Ltd., Huddersfield, England, is planning to attend the American Gas Association Convention at Atlantic City in October. W. C. Holmes and Co., Ltd. are members of the Association of Gas Appliance and Equipment Manufacturers.

Mr. Gibbons is due to arrive in New York October 7, and expects to join the members of the staff of the Roots-Connersville Blower Co. while attending the convention.

W. C. Holmes and Co. manufacture the Holmes-Connersville exhausters, blowers, compressors, pumps, etc. and also complete installations for the recovery of coal by-products; purifiers, gasholders, cast iron and steel tanks.

■ ■

Jilbert Resigns as Roper Corp. Vice-President

Harry J. Jilbert, vice-president of the Geo. D. Roper Corp. resigned from his active position September 1, after completing 35 years of association with the company.

When the Roper interests merged their various companies in 1918, Mr. Jilbert became vice-president and works manager, a position which he held until five years ago, when he resigned as works manager to devote his attention to executive duties.

On August 26, a number of Roper men attended a testimonial dinner honoring Mr. Jilbert. At that time a watch was presented to Mr. Jilbert as a token of the Roper organization's regard.

■ ■

Memphis Co. Enlarges Plant

The Memphis Natural Gas Co., Memphis, Tenn. is adding two 600 hp., six-cylinder Clark "Angle" compressors to their Guthrie, La., booster station. The station now contains four twin-tandem, 1250 hp. horizontal units. The new 300 r.p.m. angle units are being added to give the station more flexibility and additional capacity.

Winter is Succeeded by Wolf As President of Atlanta Co.

W. W. WINTER, for six years president, Atlanta Gas Light Co., Atlanta, Ga., has resigned from his duties with that company to take the position of president of the Jefferson Island Salt Co., Louisville, Ky. H. Carl Wolf succeeds Mr. Winter as president of the Atlanta company. Mr. Wolf has resigned as president of the Central Indiana Gas Co. and Hoosier Gas Co., Muncie, Ind., to be succeeded by Guy T. Henry, vice-president of the Roanoke Gas Light Co., which operates in Virginia.

W. W. WINTER

Upon taking his new position, Mr. Winter becomes president and general manager of the Jefferson Island Salt Mining Co., Jefferson Island, La. Mr. Winter has, in addition to relinquishing his duties with Atlanta, resigned as president of the Macon Gas Co., Georgia Public Utilities Co., Florida Public Utilities Co., Mobile Gas Service Corp., and the Mississippi Public Service Co. These companies, as well as Central Indiana and Hoosier Co., are all subsidiaries of the Consolidated Electric and Gas Co., Jersey City, N. J., and are supervised by Stone and Webster Engineering Corp.

WHERE MOUNTAINS AND OCEAN MEET!

That's literally what happens in Santa Cruz—Northern California's leading beach and mountain resort.

Come and see for yourself the many enjoyments of both beach and mountains—all within the radius of a few short miles on excellent highway.

Equally delightful summer and winter—Come often and stay as long as you can!

SANTA CRUZ—Home of the General Offices of

COAST COUNTIES GAS AND ELECTRIC COMPANY

SALES SLANTS

A month by month presentation of experiences on the sales front.

These Three Big "Do's" Will Win Gas Appliance Sales

A SALESWOMAN who has been very successful in training women to sell gas appliances has this to say about her selling methods:

"I teach my people to do three things: first, show the customer the merchandise; second, tell her about it; and third, ask her to buy. If those three things are done intelligently in the order named, a sale becomes almost automatic.

"In showing the customer the merchandise — that is, allowing her to look over the various types, sizes, and makes of appliances on the floor—the salesperson has an opportunity to get a case history of the prospect. Women are only too glad to talk about their families and homes, and it is no trick at all to find out how many people are in the family, their cooking preferences (assuming that she is looking at a gas range), the sort of home in which they live, and any other similar information that will be helpful in determining the needs and preferences of the customer.

"From the information obtained during this stage of the contact, the salesperson should be able to select exactly the type, style and size appliance the customer should have to fit her individual requirements. In fact, the salesperson, being a specialist in the field of household appliances, knows better than the customer herself what she wants; and it is up to the salesperson to sell that appliance to the prospect—to tell her about it so convincingly that no doubt will remain in her mind that that is the range she wants.

"Now comes the final step: asking the customer to buy. You have shown the prospect all the merchandise on the floor; you have convinced her that a specific appliance fits her needs; she is sold on that particular appliance and wants to buy it—so, there is only one thing left to do, give her that opportunity. Ask her to buy.

"How can you ask her to buy? Very simply. Just say, "Now, if you will step over to this desk, we will draw up a contract and the range will be delivered whenever you wish.'

"If you have done a proper selling job in the first place, the customer will follow quite naturally without any hesitation.

"I discovered this formula early in my sales career and I know it works."

■ ■

In the Words of Ruskin "Put Your Heart Into Your Sales"

MEN ARE rated as wise because they say and do wise things. Their wisdom is something that helps those of us who are less wise, to get more out of life.

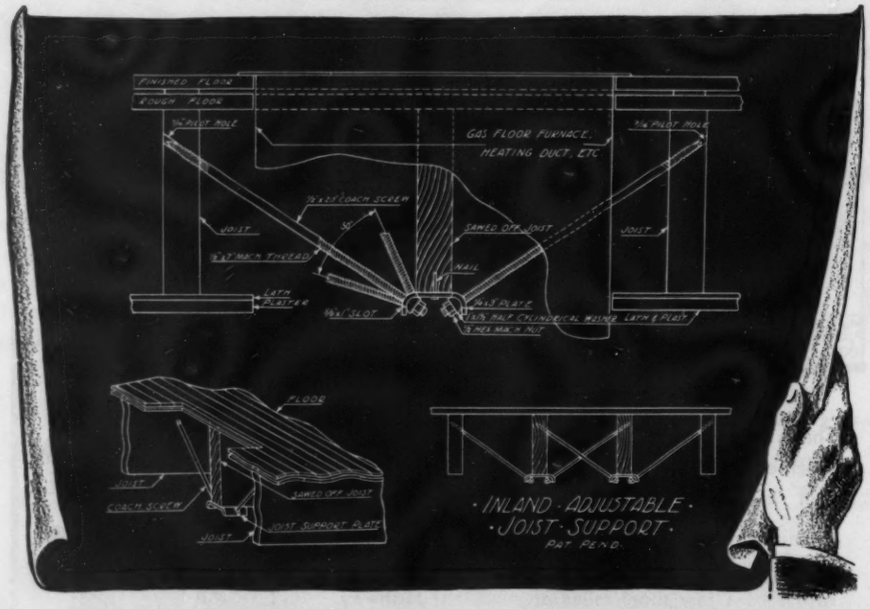
Read what John Ruskin said nearly a century ago:

"We are not sent into this world to do anything into which we cannot put our hearts. We have certain work to do for our bread and that is to be done strenuously; other work to do for our delight and that is to be done heartily; neither is to be done by halves or shifts, but with a will; and what is not worth this effort is not to be done at all."

That is real wisdom . . . . Ruskin says in a few words what all successful men know to be perfectly true. These men will tell you that it is the "Kick" that they get out of their work which is the real motive power in their drive from one success to the next.

By the same token, it means that no man can succeed in any job which he doesn't like.

Every salesman should be a salesman by choice and so in love with his work that he'd rather sell than eat. Then, he's on the way to being a top-notcher.



INLAND ADJUSTABLE JOIST SUPPORT

Heating engineers and mechanics have pronounced this the only practical device for supporting joists that must be cut to install gas floor furnaces, floor registers, duct work, piping.

The Inland Adjustable Joist Support takes only a few minutes to install and requires no special tools or skill. Gives a strong, rigid, permanent support that prevents sagging joists or creaky floors. Cuts installation costs and increases customer satisfaction.

Write at once for descriptive circular, or send for sample set.

◆

INLAND GAS SPECIALTIES

INLAND MANUFACTURING CO.
1120 North Cicero Avenue Chicago, Illinois

ADD DEPENDABLE VENTING to the convenience of GAS HEATING

MADE OF ASBESTOS AND CEMENT, Transite is unusually resistant to corrosion. It minimizes venting troubles, helps keep customers sold on gas heating.

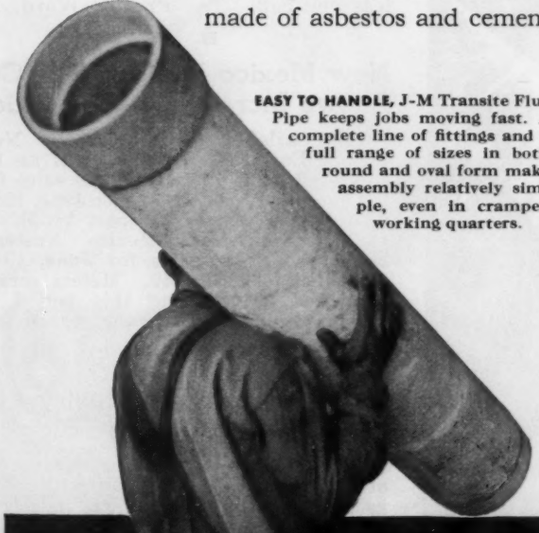
...with durable, economical J-M TRANSITE FLUE PIPE

EVERY DAY, more and more home owners are won over to heating by gas . . . sold on its convenience and reliability.

But keeping them sold is also important. That calls, among other things, for efficient venting systems that stand up under tough service conditions. And by seeing to it that Transite Flue Pipe is installed on all your jobs, you assure long, dependable service . . . provide the greatest possible freedom from costly repairs and replacements.

For J-M Transite Flue Pipe, made of asbestos and cement, is weatherproof and remarkably corrosion-resistant. Approved by the National Board of Fire Underwriters, this material is absolutely fireproof. Its low conductivity keeps stack temperatures high for long distances . . . improving draft and minimizing condensation. And it is quickly, easily installed—even in cramped working quarters.

Like many gas companies throughout the country, you'll find that the virtually trouble-free service your customers get from this lasting flue pipe helps keep them sold on gas heating. For full details, write for the Transite Flue Pipe brochure. Johns-Manville, 22 East 40th Street, New York City.



EASY TO HANDLE, J-M Transite Flue Pipe keeps jobs moving fast. A complete line of fittings and a full range of sizes in both round and oval form make assembly relatively simple, even in cramped working quarters.

THIS FREE MANUAL

is packed with valuable information that will help you work out tough venting problems. It contains 20 pages of detailed drawings on Transite Flue Pipe installation—complete information on sizes, weights and prices. Write for your copy.

JOHNS-MANVILLE JM PRODUCT

Johns-Manville TRANSITE FLUE PIPE

Three Sales Steps—Point Out Emphasize, Demonstrate

THE importance of demonstrating sales points is thoroughly emphasized in the appliance sales manuals on gas ranges, water heaters and refrigerators, issued by the Public Service Company of Northern Illinois, and used by its salesmen.

In the gas range manual, for example, under the heading "Benefits and Demonstration of the Modern Gas Range," the salesman is told "In your sales presentation point out, emphasize and *demonstrate* those advantages in which you have found your prospect shows particular interest. Summarize in closing."

Then follows in three columns a complete summary of the selling points of the modern gas range classified:

1. The benefits and appeals.
2. The reasons.
3. The demonstration.

As an example of how thoroughly the subject is covered under "The benefits and appeals," the salesman is told "No need of specially designed cooking utensils." Under "The Reasons" it says, "Any type of cooking utensil can be used for either the 'water-less' or older cooking methods." And in the third column under "The demonstration" the salesman is advised "Have at hand an old cheap pan. Place it over the burner . . . 'any pan like this will do.' Mention the need for a tight cover with 'water-less' cooking."

The Public Service Company of Northern Illinois is a firm believer in the need for a salesman to be thorough, and being able by actual demonstration, to show the practicability of everything he claims for the appliance he is trying to sell.

■ ■

Federal Lands to Be Leased

In the Cut Bank oil and gas field, Glacier county, Mont., 400 acres of federal lands are being offered for bid by the United States Department of the Interior, according to an announcement from the Great Falls offices of the U. S. Land Office.

BUILD LOAD WITH *Satisfied* CONSUMERS*

* The BEST way to assure *complete* consumer satisfaction with gas as an economical fuel is to recommend an inspection of the COMPLETE LINE OF

PACIFIC GAS HEATING APPLIANCES

THERMOLATORS
RADIANT CIRCULATORS
WALL HEATERS
RADIANT HEATERS
FLOOR FURNACES
GRAVITY FURNACES
CENTRAL BLOWER FURNACES
INDUSTRIAL UNIT HEATERS
FORCED-AIR UNITS
WATER HEATERS

Pacific
GAS RADIATOR CO.
1740 W. Washington Blvd., Los Angeles, Calif.
Manufacturers of the Most Complete Line of Gas Heating Appliances in the West

Pacific Multi-Tubular Burners Set a New High in Gas Heating Economy and Efficiency. Orifices Precision Drilled at Factory to Assure Perfect Combustion Permanently.

Remember—One More Call May Mean One More Sale

MOST every successful* salesman has, at one time or another, had to battle his weaker self, which keeps supplying him with reasons why the prospect should not be called on today. A new salesman, especially, is often bedeviled by reasons as to why he should skip the call he dreads to make. Most of these reasons are inspired by a fear of a turndown.

If you fear turndowns, here is a story that the law of averages has to tell:

9 turndowns.....2 orders
18 turndowns.....4 orders
27 turndowns.....6 orders

So if you're a salesman, the next time you start running into a lot of turndowns, why not count the turndowns, remembering that every time you get one you are that much nearer to an order.

And while you're kidding yourself with reasons as to why the prospect should not be called on, think of this:

The sale cannot be started—unless you call.

You cannot get acquainted with the prospect—unless you call.

You cannot develop ideas for him—unless you call.

You cannot answer his objections—unless you call.

He cannot have any confidence in you—unless you call.

You cannot destroy your fear of failure—unless you call.

You cannot get his order—unless you call.

You're selling yourself "short"—unless you call.—*The Printed Word.*

■ ■

New Mexico Eastern Gas Co. Shows Increase in Gas Sales

The Carlsbad district of the New Mexico Eastern Gas Co. showed an increase of $8,236.55 in total gas sales for the month of June, 1938, over June, 1937, according to a recent report by H. N. Oldham, of New Mexico Eastern. Revenue for gas sales for June, 1938, amounted to $25,945.49. Meters served numbered 3056 during this period as compared with 2689 for the corresponding month in 1937.

■ ■

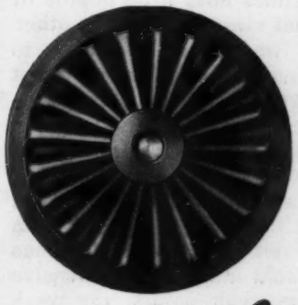
Rector to Be Gas Industry Host at N.Y. World's Fair

George Rector, renowned epicure and authority on food preparation, will act as the official host at the gas industry's "Court of Flame" exhibit at the New York 1939 World's Fair, according to an announcement by Hugh H. Cuthrell, president, Gas Exhibits, Inc. In the exhibit auditorium Mr. Rector will demonstrate his cooking methods.

* Reprinted from *Gas Service*. Gas Service Co., Kansas City, Mo.

On all types of Heating Control

SAVE TIME, TROUBLE AND MONEY



with this Simple Snap-Acting DISC

The advantages that you get out of Klixon Heating Controls come from their positive operation. Instead of using relays, magnets, toggles, bellows or other slow-moving, troublesome parts, Klixon controls are operated by a snap-acting thermostatic metal disc. And because this disc cannot wear out or lose its factory calibration — and because it is vibration-proof, non-radio-interfering and not affected by dust—Klixon Controls give better, more dependable operation under practically all conditions.

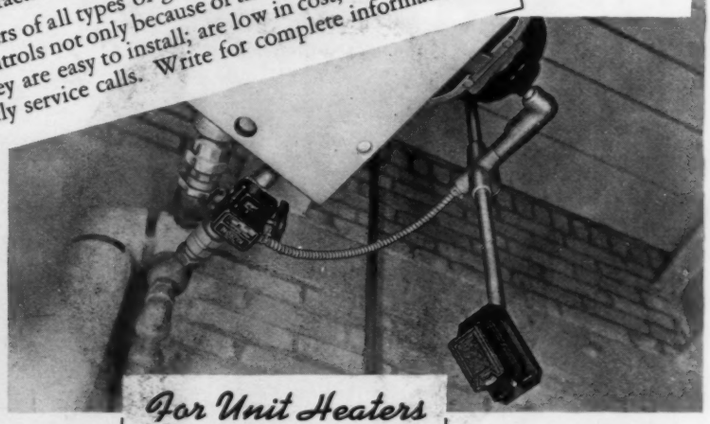
Manufacturers of all types of gas heating equipment specify Klixon Controls not only because of their operation but also because they are easy to install; are low in cost; and they cut down costly service calls. Write for complete information.

For Hot Water

The Klixon ST Control provides close high or low limit boiler control—insures safety, economy and more uniform room temperature control. Easy to install—on surface or immersion. Suitable for 2 or 3 wire low voltage or 110 volt A. C. line service.

For Hot Air

Klixon BT Warm Air Controls provide accurate control of temperatures in hot air bonnets or ducts. Can be used for high or low limit control or both, for fan switch control or combination limit and fan switch control. Easy to install. Line or low voltage.



For Unit Heaters

A Klixon Room Thermostat saves up to twelve dollars per unit heater installation. Thermostat is suspended from heater by short pipe. No long conduits necessary. Thermostat hangs in best possible control point. Easily set from floor.

For Steam Heat...

For automatic control of pressures in low-pressure steam heating boilers use the Klixon PS Pressure Switch. They are snap-acting and positive in operation. Independently adjustable both as to cut-in setting and differential. Tamper-proof. Line or low voltage.

For Space Heaters

With this Klixon Gas-Electric Valve there is no hum, no chattering, no sticking, no ambient or solenoid valve troubles. For it is thermally operated —by the Klixon disc. Easy to install. Line or low voltage. Capacities to 195,000 Btu. Sizes to ¾" I.P.S.

KLIXON
TRADE MARK REG U.S. PAT. OFF.

SPENCER THERMOSTAT CO., 709 FOREST ST., ATTLEBORO, MASS.

5207

"What's Wrong With 'I'?"

HAVE you ever tried* to put something across and it did not register? As a result you blamed the other fellow. A salesman called on a company with a great deal of enthusiasm recently, presenting a proposition, that, to the salesman seemed to be perfect and could not be refused. Strange to relate, however, his eloquence failed to create interest and the plan did not impress his customer as being acceptable.

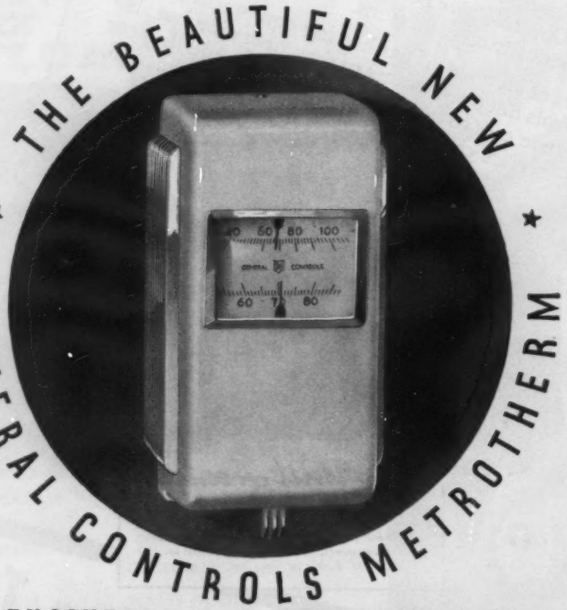
The potential customer came in for some very vivid criticism from the salesman. Did this criticism help the salesman? It did not. The salesman would have helped himself if he had only taken the trouble to examine his own methods before he criticised his prospect.

A noted financier who had been very successful was asked one time to what he attributed his success; his answer was, "When I find my ideas or suggestions or instructions are not receiving an enthusiastic response I always examine myself for I feel the lack of interest is my own fault."

We sometimes miss little details in our plans that mean much to the other fellow, and we should remember to make the best impression, we must think in terms of the person or persons we wish to impress. Let us not pat ourselves on the back and say, "I am all right, but the other fellow is lacking in vision." What do we call such an attitude? Well, it is a form of egotism—let us call it unconscious ego. We should analyze our offensive and find the weak points, for weak points there must be.

To make one respond to our appeal we must be interesting, we must have an intelligent approach that is clear and understandable. We must be able to show our prospect how he can profit by our proposition and, above all, we must live up to every statement we make. Under such circumstances we shall never need ask ourselves "What's wrong with 'I'?"

* Karl F. Westermann in *United Effort*, published in *A News Letter* issued by the Public Utilities Section of the National Safety Council, Inc.



ENGINEERS O. K. ITS ACCURACY
Accurate, rapid response. Adjustable heat acceleration.
ARCHITECTS PRAISE ITS BEAUTY
Now finished in ivory and chrome. New detachable wall plate.
HOME OWNERS LIKE ITS EVEN-HEAT CONTROL

GC
GENERAL CONTROLS
A product of
NEW YORK, 267 Fifth Ave. • CLEVELAND, 1505 Broadway • CHICAGO, 450 East Ohio Street • HOUSTON, Press Building • LOS ANGELES, 700 West Ivy Street, Glendale • SAN FRANCISCO, 915 Bryant Street

To Tell Them the Truth—Sell Them the Truth

SOMETIMES it is necessary for a salesmanager to tell one of his men something for his own good, something which is not complimentary. How can he do so without giving offense?

Here's how one salesmanager gets around the problem.

"I sell them the truth," he says. "Here is Joe Bush, a crackerjack salesman, liked by everybody, always ready with a good story or helping hand. Lately, however, I've noticed he's getting careless about his dress, neglects to shave, goes without a shine. I call him in.

"'Joe,' I say, 'how much would you give me for my job if I showed up here in the morning without shaving, didn't keep my shoes polished, and forgot to have my clothes pressed? You and everybody else would be saying the boss is slipping; he's losing his grip; he's on the way out. Am I right?'

"'Joe,' I say. 'You're a swell guy and a good salesman and a big asset to this firm. I want to keep you that way. I don't want people to go around saying poor old Joe Bush is losing his grip. They certainly couldn't say anything like that if you made an effort always to look your best. How about it?'

"A man is not much of a salesmanager if he can't wrap the truth up in a package that will sell to his men."

■ ■

A.G.A. Commercial Section Preparing New Sales Course

THE American Gas Association through J. W. West Jr., secretary of the Commercial Section, announces a new training course in selling gas service and gas appliances to residential customers. Now being prepared under the supervision of the Commercial Section, it is planned to have the course ready about November 1.

This new course is being prepared by Trade-Ways, Inc., formerly Business Training Corp., the organization that produced the A.G.A. course in Domestic Gas Salesmanship some years ago.

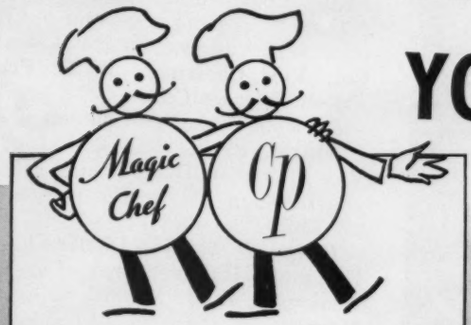
■ ■

United Gas Corp. Launches Better Heating Campaign

The United Gas Corp., Houston, Texas, officially launched its 1938 Better Heating Campaign on August 25. The campaign is scheduled to continue through September, October, and November.

Campaign advertising will feature two themes. The first series of advertisements are to be based on "Home Sweet Home" with its comforts increased by the installation of automatic gas heat. "Better Heat—Better Health" will be the slogan for the second advertising series.

HERE'S THE TEAM THAT WILL BOOST YOUR SALES THIS FALL



● To give you a better CP range, Magic Chef is introducing a new improved series of SUPER - CP MAGIC CHEF RANGES.

The range illustrated is one of the new 3100 series. This neat, compact range (only 42" wide) will be a money-making sales booster for you this Fall. It is equipped with three-in-one burners, insulated oven and broiler . . . not to mention the other sales-building features like folding cooking-top cover, new style burner tray, famous Red Wheel Regulator, new grid-pan broiler, electric light and timer.

These exclusive Magic Chef features have been developed after years of research and the expenditure of millions of dollars. As always Magic Chef will continue to build better ranges and to acquaint the public with the superiority of cooking with gas.

Get ready for bigger sales this Fall.

AMERICAN STOVE COMPANY

Boston New York Philadelphia
Atlanta Cleveland Chicago
St. Louis San Francisco Los Angeles

Magic Chef
THE GAS RANGE WITH
THE FAMOUS RED WHEEL

6 REASONS WHY THE MAGIC CHEF LINE SELLS FASTER

Magic Chef Super CP ranges more than meet each of the 22 exacting specifications of the A.G.A. for CP rating. Here are 6 of the outstanding advantages that will help you sell more Magic Chefs this Fall:

1. BETTER TOP COOKING. New 3-in-1 non-clog burners light automatically, give any desired heat—high, low, simmer—instantly.

2. BETTER OVEN COOKING. Accurate, uniform heating controlled by famous Red Wheel Regulator. Preheats to 500° in 7 to 8 minutes.

3. BETTER BROILING. Automatic-lighting swing-out broiler in separate high compartment makes broiling fast and easy. Smokeless grid-pan.

4. BETTER CONSTRUCTION. All steel throughout. Rigid interior structure. Ranges fit flush against backwall and side cabinets.

5. BETTER CLEANING FACILITIES. Exterior finish, broiler and oven linings are smooth, washable, porcelain enamel. All parts quickly removable and easily cleaned at sink.

6. BETTER DEPENDABILITY. Developed in the only complete manufacturer's research laboratory in the industry. Built by the largest manufacturer of gas ranges in the world—backed by world-wide reputation for quality.

GAS IS YOUR QUICK, CLEAN, ECONOMICAL SERVANT

H. L. Farrar is Nominated for P. C. G. A. Presidency

NOMINATIONS for the executive positions in the Pacific Coast Gas Association will be presented before the opening general session of the 45th Annual Convention at Santa Barbara on Wednesday morning, September 14. The nominations are as follows:

For President—H. L. Farrar, president, Coast Counties Gas and Electric Co.

For Vice-President—A. E. Holloway, vice-president in charge of sales, San Diego Consolidated Gas & Electric Co.

For Treasurer—D. G. Martin, general auditor, Pacific Gas & Electric Co.

For Directors—R. G. Logue, vice-president, Ward Heater Co.; J. J. Winn, Jr., commercial manager, Portland Gas and Coke Co.; R. E. Easton, president and general manager, Santa Maria Gas Co.; W. R. Smith, Continental Water Heater Co., Ltd.

Retiring P. C. G. A. President Norman R. McKee automatically becomes a member of the board of directors.

Members of the Nominating Committee include the following: H. L. Masser, vice-president, Southern California Gas Co. (chairman); R. N. Dreiman, asst. treasurer, Coast Counties Gas and Electric Co.; R. C. Hoyt, president, Hoyt Heater Co. of Northern California; T. E. Roach, president, Washington Gas and Electric Co., and E. H. Roseberry, branch manager, Sprague Meter Co.

H. L. FARRAR
1938-39 Presidential Nominee

A. E. HOLLOWAY
Vice-presidential Nominee

At the annual meeting of the Manufacturers' Section, the Nominating Committee will present the following recommendations:

General Chairman—R. G. Logue, Ward Heater Co.

General Vice Chairman—W. R. Smith, Continental Water Heater Co.

Direct Heating Division—Chairman, J. S. Andrews, Andrews Heating Co.; Vice Chairman, R. E. Fraser, Fraser Furnace Co.

Furnace Division—Chairman, A. J. Hartfield, Pacific Gas Radiator Co.; Vice Chairman, Don Fleming, Electrogas Division, Payne Furnace & Supply Co.

Range Division—Chairman, Geo. Hammer, Hammer-Bray Co.; Vice Chairman, R. J. Merritt, O'Keefe & Merritt.

Water Heater Division—Chairman, A. H. Sutton, Mission Water Heater Co.; Vice Chairman, B. A. Hinckley, General Water Heater Co.

The Manufacturers' Section Nominating Committee is as follows: K. C. Tomlinson, Pacific Meter Works (chairman); E. P. Millikan, American Stove Co.; E. L. Payne, Payne Furnace & Supply Co.

■ ■

Ohio Fuel Co. Launches 13-Week Sales Drive

The Ohio Fuel Gas Co., Columbus, launched a 13-week sales drive on gas heating equipment, August 1, according to announcements by district managers of the company. Featuring all types of modern gas heating equipment for both home and commercial use, the campaign will be supported by a comprehensive newspaper advertising program and other sales promotional efforts.

During the campaign the Ohio Fuel Co. is offering a free heating survey for any family interested in gas heat. The survey includes an inspection of the present heating plant and an estimate of the cost of heating the home or business establishment with gas.

■ ■

Gas Refrigeration Promoted By Public Guessing Contest

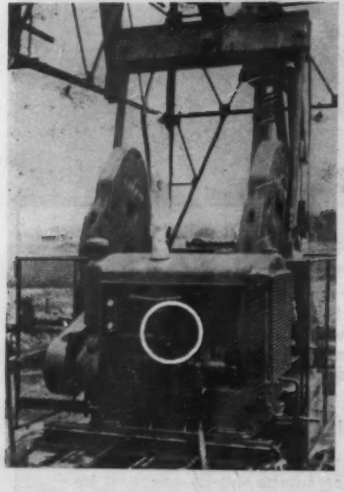
The Texas Cities Gas Co. at El Paso recently cooperated with the American Furniture Co. of that city in sponsoring a public guessing contest, the object of which was to guess the number of cubic feet of natural gas consumed by a 1938 H800 Electrolux gas refrigerator during a period of 28 days. Three prizes of $35, $10, and $5 were awarded contest winners. The total number of guesses submitted was 1587.

■ ■

Public Utilities of W. Va. To Hold Annual Convention

The Public Utilities Association of West Virginia will hold its 20th Annual Convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., September 30 and October 1. J. K. Buchanan, association president, has appointed the following committee on program and entertainment: W. A. Buchanan, D. E. Stultz, T. J. Blair, Jr., J. C. Smith, Mrs. A. J Darrah, and A. Bliss McCrum.

LEADING ENGINE BUILDERS CHOOSE ENSIGN



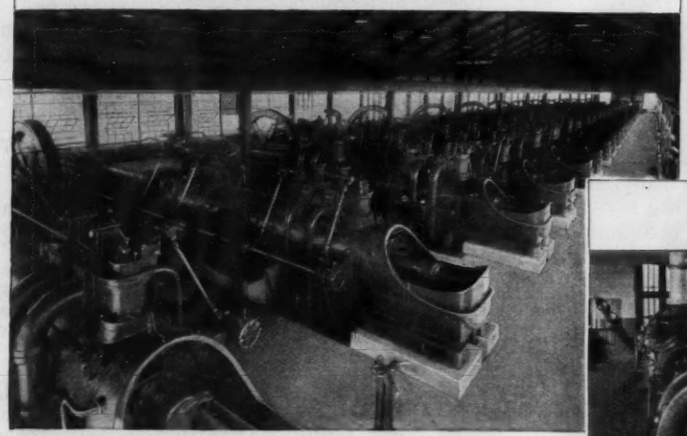
Standard equipment with approximately 90% of the leading engine manufacturers, ENSIGN Carburetors help assure the dependability and economy of engine operation so necessary in severe oil field service.

ENSIGN Gas, Combination Gas and Gasoline and Butane Carburetors are noted the world over for quality and efficiency. For well servicing, drilling, pumping, auxiliary equipment and all other engine uses be sure it's ENSIGN—for best results!

MINNEAPOLIS-MOLINE Oil Field Engines have proved their economy and dependability for the past 20 years for oil producing companies throughout the industry. At left is shown an MM pumper operated on Natural Gas with an ENSIGN Carburetor and Fuel Regulator.

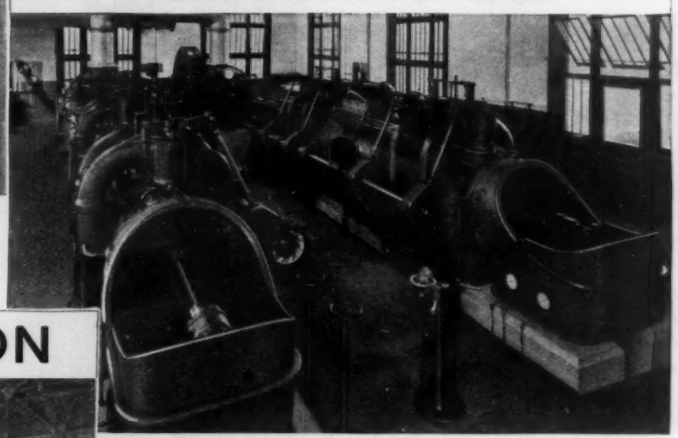
ENSIGN CARBURETOR CO., LTD.
LOS ANGELES · DALLAS · CHICAGO

TRANSPORTATION



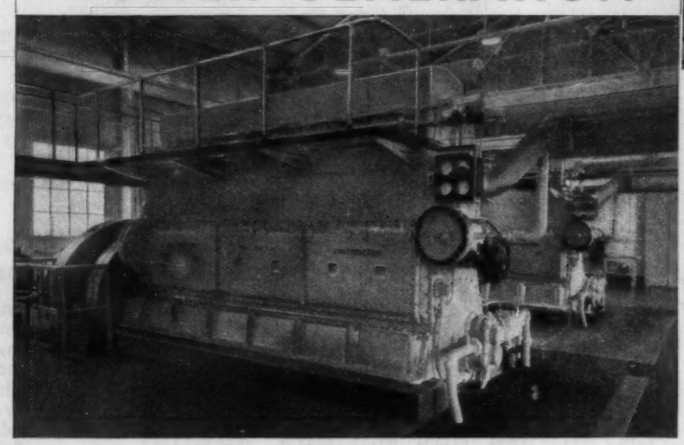
Fifteen Worthington 1300-horsepower 24"x 36" Horizontal Twin-Tandem Gas Engine Gas Compressors, in a large natural gas pipe line station

DISTRIBUTION



One of two Worthington 900-horsepower 20"x 30" Horizontal Twin-Tandem Gas Engine Gas Compressors, operating on manufactured gas, in a large utility gas distributing station

POWER GENERATION



Worthington 750-horsepower Vertical Convertible Gas-Diesel Engine in power service

From Field to Market...

WORTHINGTON EQUIPMENT PREDOMINATES

WHETHER for transportation or distribution, Worthington Gas Engine Gas Compressors are distinguished for their reliability and economy. For expanding the market for gas, Worthington power units are available in the convertible type from 50 to 1500 horsepower capacity.

The convertible feature provides definite insurance against failure of the fuel supply, as a quick change-over can be made in a few hours at low cost, and the engines will give the highest economy on either gas or oil.

Worthington engineers, backed by years of experience, are available to help *your* engineers with their problems.

• *Literature is available on request*

WORTHINGTON PUMP AND MACHINERY CORPORATION

General Offices: **HARRISON, NEW JERSEY** - *Branch Offices and Representatives in Principal Cities throughout the World*

WORTHINGTON

GEB-4

Wisconsin Home Service Department Aids Invalid Customer by Telephone

IN Green Bay, Wis., for over three years a woman has been completely bedridden and an invalid for 16 years. At her bedside is her telephone, her chief means of communication with the world around her, especially the home service department of the Wisconsin Public Service Corp.

Miss Zella Patterson, home service director, at Green Bay has known this bestricken woman as one of her most stalwart supporters for some years in the home service work that Miss Patterson is doing.

"A few years ago," says Miss Patterson, "during a telephone call for home service information, I learned that this lady had been bedridden for years, directing cooking, canning and other household activities nevertheless.

"I found her a most charming and interesting woman in most modest circumstances. She is almost helpless not being able to use her hands and to move her arms slightly. In fact the telephone is so arranged that with a crook of her arm she can pull it to her in her bed. In spite of this handicap, she is very much interested in the latest ideas in homemaking and was delighted, she says, to learn from a friend that she could call our department at any time for recipes or other information, because the telephone is the only means she can use for communication. She is the mother of two children. The housework is done by a part-time maid, helped by the husband and son.

"One of the tangible results of her excellent planning and management is her well-stocked fruit and vegetable storeroom. She tells me last year she had canned 490 quarts of all varieties of food. She is rather proud of her applesauce, of which she has canned 45 quarts so far this year. A little kink which she tried out without authority was that of tying white cheesecloth on top of hot apple sauce in the jar, sprinkling with cinnamon and then putting on the cover and tightening it. She says there is absolutely no mold on it when she uses this method. She also canned large quantities of pickles in many varieties."

Miss Patterson reports that her invalid customer is always cheerful and a confirmed optimist.

■ ■

Ruth Soule of Brooklyn Union Writes "CP" Range Ad

Ruth Soule, home service director, The Brooklyn Union Gas Co., inspired by the better cooking performance of "CP" ranges, found time to leave her regular duties and become pamphleteer. Her copy appears in literature prepared and distributed by the Brooklyn Union Gas Co. It reads:

C. P.

C. P. ranges are the result of Careful Planning by a Committee composed of gas utility merchandise managers and manufacturers of better grade gas burning appliances and are the answer to a public demand for Cooking Perfection.

This is a Century of Progress

Modern appliances for the home are the order of the day.

Carefree Pleasure is in store for the woman who uses the C. P. Range.

Control and Precision are assured by the new type automatic features of these ranges.

Clean Pots, Clean Pans, Cool Premises, are all attractive to modern housewives and are assured by this latest revolutionary cooking appliance.

Cook Perfect meals with C. P. Ranges

■ ■

Myerstown, Pa., Motor Police School Uses Gas Appliances

The Pennsylvania Motor Police Temporary Training School in Myerstown, Pa., is using gas appliances for cooking purposes. Training school equipment, needed to serve the 500 men housed in the Myerstown institution, includes two heavy duty hotel ranges, two 48-in. griddles, two deep fat fryers, two coffee urns, and one bake oven.

In addition to the above, a small gas-fired boiler supplies steam for pressing uniforms. The school is furnished gas by the Lebanon Valley Gas Co., Pa.

■ ■

Oklahoma Natural Has New Home Service Director

Rosemary Locke took office as home service director for the Oklahoma Natural Gas Co. in Enid on July 25, according to a recent announcement by J. A. Ray, district manager for the company. For the past three years home service director in the Tulsa district office, Miss Locke replaces Doris McKnight who resigned July 1.

■ ■

Dallas Schools Have Modern Gas Ranges Installed

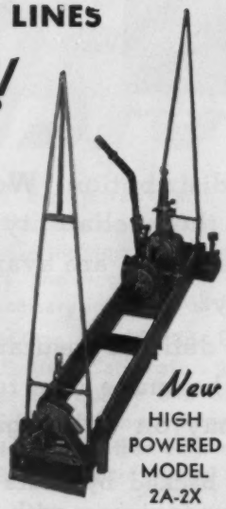
With the installation of seven 1938 model gas ranges in two Dallas, Texas, high schools in July, the school home economics departments of that city joined the swing to modern gas cookery. Six ranges were installed in the North Dallas High School and the other at the Forest Avenue School.

Underground

PIPE AND CONDUIT LINES

as by Magic!

So quickly and so efficiently does the Hydrauger install Underground Piping that it seems like Magic! No ditching, no pavement cutting, no backfills, no after-settling; that's Hydrauger's way of saving 90% on every underground pipe installation. It bores a clean open-hole horizontally under pavements, traffic, gardens, railroads, embankments—right through sand, clay, conglomerate, rock, shale or any underground formation. Pipe slips through this hole readily and without damage to its protective wrapping or coating. Hydrauger operates economically and does not hazard vehicular traffic in any way.

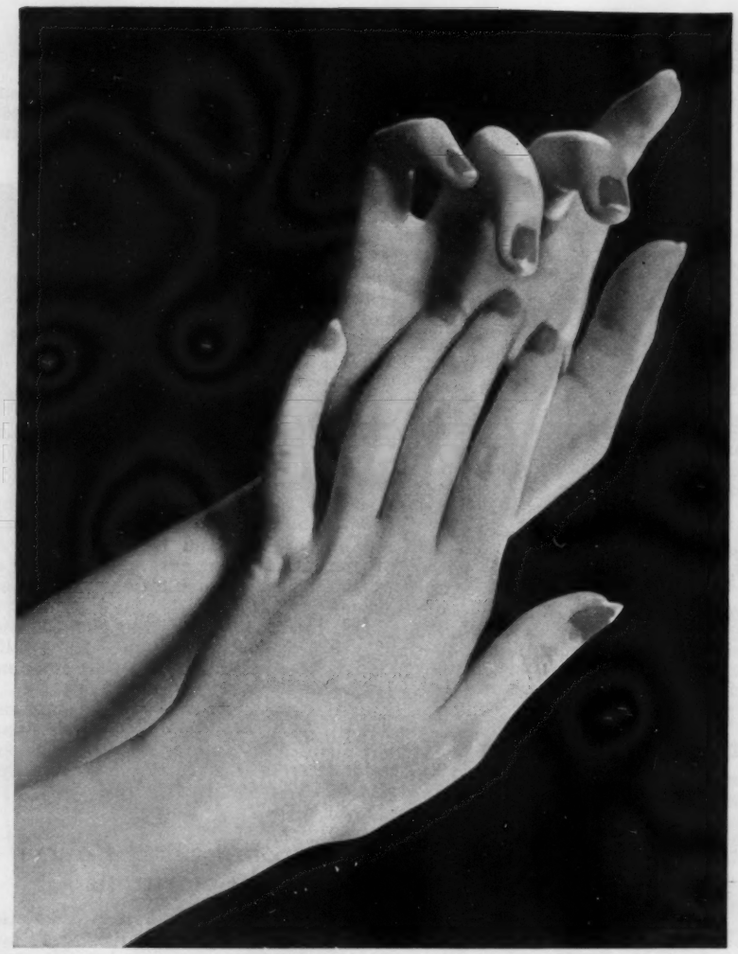


New HIGH POWERED MODEL 2A-2X (Patented)

Operated by a powerful air-motor. Can bore 4½" hole at a foot per minute! Target "sighting" controls boring accuracy.

HYDRAUGER CORP., Ltd.
116 New Montgomery Street
SAN FRANCISCO
Send for Bulletin No. 5

HYDRAUGER
"The Mechanical Gopher"



BLACK BOX, N. Y.

Not for a Coal Shovel

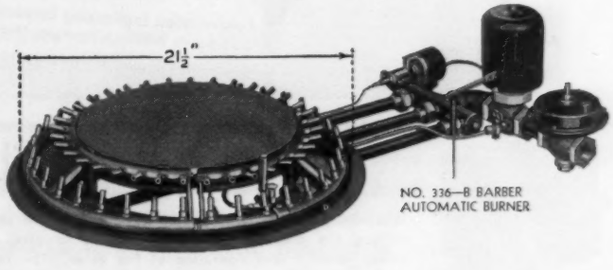
Beautiful hands—any woman feels proud to have them. But firing an ordinary solid-fuel furnace is certainly no help to milady's hands. It takes more than a manicurist to lick the coal shovel. It takes GAS.

•

Equipment for automatic gas heat can, and should, be sold not only on the basis of comfort and economy—but as a method of freeing American housewives from antique drudgery. Show your feminine customers how easily they can heat with gas and use the *furnace now in the house.* Barber Conversion Burners will increase your sales to *satisfied* customers.

•

The "B" Model shown comes in 8 sizes for round grates 12" to 34" in diameter. There is also a wide range of sizes for oblong grates. Patented BARBER Jets insure complete combustion, with a "scrubbing" flame action on walls of firebox. No fire brick or refractory elements needed. Baltimore Safety Pilot. Listed in A. G. A. Directory of Approved Appliances. Ask for Catalog and Price List on Conversion Burners for Furnaces and Boilers, Burner Units for Gas Appliances and Gas Pressure Regulators. We supply sales folders, at your request, for mailing to your customers.



NO. 336—B BARBER AUTOMATIC BURNER

•

THE BARBER GAS BURNER CO., 3704 Superior Ave., Cleveland, Ohio

***Address Michigan Inquiries to* The Barber Gas Burner Co. of Michigan, 4475 Cass Ave., Detroit**

BARBER *Automatic* JET GAS BURNERS

Merced-Livingston Gas Line To Be Complete in September

CONSTRUCTION of the new natural gas line of the San Joaquin Light and Power Co., Fresno, Calif., from Merced to Livingston is now under way, and, according to a recent announcement by Raleigh Casad, Merced district manager for the company, the line should be completed by approximately September 15.

The line, which is being built of eight-in. main, at an approximate cost of $250,000, will bring natural gas service from the Kettleman Hills fields to both Atwater and Livingston, neither of which has had gas service before.

A crew of 65 men has been working on the construction of the line and the distribution mains in Atwater. Latest reports reveal that already 5000 ft. of mains have been laid within the city limits of Atwater while the 14-mile transmission line northward from Merced was to have been completed in August.

Franchises were granted to the San Joaquin company last Spring by both Atwater and Livingston.

■ ■

Harold P. Farrington Heads Commonwealth Gas System

The Commonwealth Gas System, New York City, effected a change of management August 1. The new chairman of the board and president is Harold P. Farrington, New York. Directors elected were Mr. Farrington; J. Truman Bidwell, J. Bay Robinson, Ronald M. Craigmyle, and R. E.Coulson, all of New York.

The Commonwealth Gas System operates and manages among others the West Virginia Gas Corp., Memphis Natural Gas Co., Atlantic States Gas Co., Inc., Texas Gas Utilities Co. and Carbons Consolidated, Inc.

Colonel George A. Burrell remains as president and Byron B. Stroud, operating manager, of Atlantic States Gas Co., Inc.

■ ■

So. Calif. Gas Co. Salesmen Learn Cooking in New Kitchen

Under the direction of Gladys B. Price, home service supervisor for the Southern California Gas Co., Los Angeles, the sales personnel of the Southern California Gas central, northern, and southern divisions, learns the selling points of gas cookery through actual cooking practice. For this purpose a new model kitchen has been created in the company's main office in Los Angeles where 10 1938-model gas ranges have been installed.

Each salesmen's cooking class meets four times. The first meeting deals with top burner cookery, the second with oven cooking convenience, while the topic of the third meeting is smokeless broiling. The final session is a demonstration comparing identical foods prepared on the best electric range and on the gas ranges.

■ ■

Hodgkins Heads Michigan Co.

W. J. Hodgkins has been elected president and general manager of the Michigan Gas and Electric Co., subsidiary of the Middle West Corp. He was formerly vice-president.

R. G. Barnett and E. L. Hall Elevated by Portland Co.

ANNOUNCEMENT that R. G. Barnett had been elected a vice president and general manager of Portland Gas & Coke Co. was made August 30 by Paul B. McKee, president.

E. L. HALL

At the same time it was announced that E. L. Hall, operating manager, had been elected a vice president and chief engineer of the company.

Mr. Hall has been with the company 32 years and has had a prominent part in the development of the company's important by-product business as well as in the working out of new and improved methods of manufacturing gas. He served as president of the Pacific Coast Gas Association in 1925.

Mr. Barnett entered the gas business 17 years ago when he joined the Pacific Gas & Electric Co. From that company he went to the Coast Counties Gas & Electric Co., where he served as manager.

For the past several years Mr. Barnett has been stationed in Rio de Janeiro as a director and executive of the Emprezas Electricas Brasileiras.

■ ■

Appalachian Short Course Draws 302 Registrants

The first annual Appalachian Gas Measurement Short Course was held August 22, 23 and 24, under the sponsorship of the West Virginia University School of Mines, Morgantown, W. Va., assisted by the West Virginia Public Service Commission, A.G.A. Natural Gas Department, West Virginia Oil and Natural Gas Association, and public utilities in the Appalachian territory. The general short course committee was headed by H. J. Wagner of the West Virginia Public Service Commission.

Registration at the three-day course numbered 302 persons. Morning sessions covered all phases of measurement and regulation and afternoon sessions were devoted to class room study of specific equipment and measurement and regulation problems.

■ ■

Centreville Gas Distribution System Allotment Granted

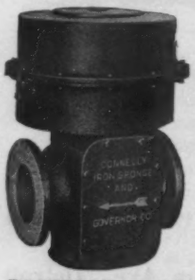
Centreville, Miss., has received a $37,500 allotment for the construction of a natural gas distribution system, according to word received in that community from P. L. Cole, WPA regional district administrator, Atlanta, Ga. The allotment consists of a loan of $21,000 and a grant of $16,500.

■ ■

W. G. Murrin Is Honored

W. G. Murrin, president of the British Columbia Electric Power and Gas Co., Ltd., Vancouver, B. C., was the recipient on July 30 of an antique silver urn and a two-tier birthday cake in honor of his 25 years of service with the company.

VITROLINER
THE PERMANENT CHIMNEY LINER
is coated inside and out with a special, high temperature, acid-resisting vitreous enamel. It prevents acid and destructive moisture from coming in contact with masonry and preserves chimneys way beyond their average life. Used by the largest utility companies in the United States and Canada.
Condensation Engineering Corporation
335 South Western Avenue, Chicago



DISTRICT — LC REGULATOR

Amazing Flexibility

This advanced Connelly design is provided with adjustable linkages, connecting the diaphragm and valve stem, to give an increased range of power ratios in the operation of the valve. The following table is based upon one-inch water column pressure differential under the diaphragm:

Size of Valve	Minimum Power	Maximum Power
23"	24.7 lb.	350.0 lb.
19"	20.8 lb.	185.4 lb.
16"	15.0 lb.	166.5 lb.

Type LC Regulator can be set to meet any requirement within the limits of the design by a simple adjustment.

Write for Bulletin No. 200-B-1

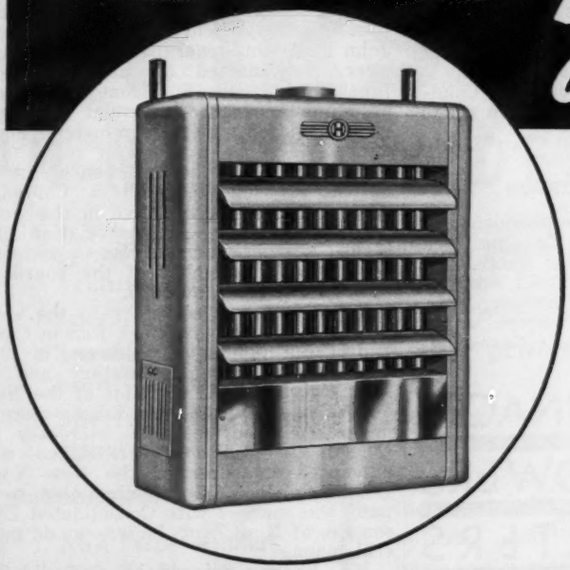
CONNELLY IRON SPONGE & GOVERNOR CO.

CHICAGO, ILL. ELIZABETH, N. J.

Pacific Coast Representative: Harry V. Payne, 3834 Third Ave., Los Angeles

BIGGER GAS LOADS AHEAD

WHEN YOU CONCENTRATE ON HUMPHREY GAS UNIT HEATERS

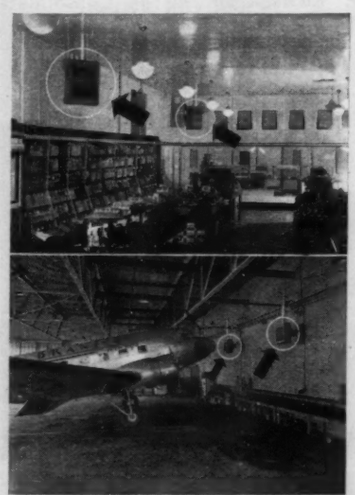


Always Easier To Sell And Easier to Service, New 1938 Features Add Even More Sales Appeal

The new and exclusive design Forced Air Combustion Burner, the new Thermolectric Pilot Control, and the new Humphrey-Baso Combination Gas Valve are 1938 developments destined to become important helps in your sales efforts on unit heaters.

These exclusive features allow us to build Humphrey Gas Units up to 30% more compact. They provide positive safety controls that are most reassuring to prospective heating customers.

Wherever your operations are concentrated — whether you sell manufactured or natural gas or both — there is a challenging opportunity to build tremendously bigger gas loads by placing Humphrey Gas Unit Heaters in factories, retail stores and shops, garages, service stations, drug and food stores, and similar buildings. The new portfolio of Humphrey Forced Circulation Heating Equipment, with suggestions on how to advertise and sell it, will soon be ready for distribution. Send for your copy today.



Here are two installations typical of the thousands that progressive gas companies have placed throughout the country. The airplane hangar installation is graphic proof that every Humphrey Unit has the approval of the Underwriters' Laboratories for such use.

GENERAL GAS LIGHT COMPANY

KALAMAZOO, MICHIGAN

23 Warren St., NEW YORK CITY 2nd Unit Santa Fe Bldg., DALLAS 475 Eleventh St., SAN FRANCISCO

C. L. WHITEHILL

H. C. McALLISTER

Whitehill, McAllister Retire As So. Calif. Gas Executives

AMONG the 30 Southern California Gas Co. service people who will retire on September 1 under the company's uniform pension and benefit plan are Charles L. Whitehill, secretary of the company, and Henry C. McAllister, manager of the eastern division, headquarters at San Bernardino.

Mr. Whitehill has a record of 18 years service with the company and 25 years service in the Kansas City Gas Co., Kansas City, Mo. Leaving the position of auditor in this latter company in 1920, he entered the Southern California Gas Co. as assistant secretary. He was made secretary in January, 1926, and has served in that capacity ever since.

Mr. McAllister has served as eastern division manager for 29 years, coming into the organization in that capacity on the purchase of a predecessor company in August, 1909. He has taken a very active part in civic and business affairs in San Bernardino throughout his years of service with the gas company.

Oldest in point of service among those retiring is James Walter Bergen, who completed 30 years of service on June 15, 1938. Mr. Bergen, a former Los Angeles Gas and Electric Corp. man, retires as a member of the sales department. The sales department, besides Mr. Bergen, loses also Robert B. Moore, dealer representative in the Pasadena district, who has completed 25 years of service; and Charles N. Roberts, assistant industrial sales manager, who has been with the company over 24 years.

Mr. Robert, who entered the service of the Los Angeles Gas and Electric Corp. in January, 1914, has been identified with the gas business for fully 50 years. He pioneered in commercial and industrial gas engineering in Los Angeles, selling the first gas furnace installed here, and introducing heavy duty gas equipment for restaurants. An outstanding contribution was his introduction of gas for use in railroad round houses, particularly for test-firing of locomotive boilers in the shops.

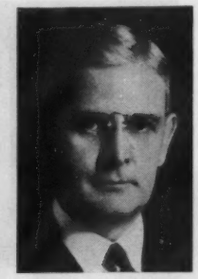
Five members of the Southern Counties Gas Co. organization will also retire on September 1.

■ ■

Carl C. Thomas Passes

Carl C. Thomas, vice-president of Dwight P. Robinson and Co., Inc., and inventor of the Thomas Gas Meter, died at his home in Pasadena, Calif., on June 6. Active in engineering research, Mr. Thomas included in his written works a paper on "Measurement of Gases."

H. C. DAVIDSON



J. H. AIKEN

Consolidated Edison Co. Elevates Executives

TRUSTEES of Consolidated Edison Co. of New York, Inc., have elected Herbert C. Davidson vice-president and chief accounting officer and Frederick W. Jesser secretary of the company, the post formerly held by Mr. Davidson. John H. Aiken, general commercial manager, was named an assistant vice-president. Joseph F. Rooney, formerly assistant general commercial manager, was appointed general commercial manager.

Mr. Davidson, who has been secretary of the Consolidated Edison Company since 1924, has been active in the work of the American Gas Association and served as chairman of its accounting section and a member of the board of directors in 1924 and 1925.

Mr. Jesser was secretary to the vice-president of the New York Edison Company for a number of years and in 1919 was made assistant secretary and in 1924 secretary. At the time of the New York Edison-Consolidated Edison merger he was elected assistant secretary of Consolidated Edison. Mr. Aiken was appointed treasurer of the New York Edison Co. in 1934 and when that company was merged with Consolidated Edison Co. of New York, he was made general manager.

Mr. Rooney joined the Consolidated Edison Co. as an office boy in 1914. In 1925, he was made assistant statistician and in August of that year became assistant to Vice-President O. H. Fogg. In July, 1936, following the merger of the New York Edison and the Consolidated Gas Companies, he was appointed assistant general commercial manager. He has been active in the American Gas Association where he served several years on the rate structure committee, and was later assistant treasurer and then treasurer.

■ ■

New Well May Serve Gas To Idaho and Oregon Towns

In Payette county, Idaho, the Jacobs No. 1 Haaken recently came in for a 20,000,000 cu. ft. flow of gas at 1200 ft. The gas is under sufficient pressure to indicate that the well can commercially serve Payette and Weiser, Idaho, and Ontario, Ore.

■ ■

Samuel McNoldy Dies

Samuel McNoldy, production foreman of the Allentown Works of the Allentown-Bethlehem Gas Co., Pa., died July 21, after 27 years association with the Allentown company.

Electrogas
FOR EVERY HEATING NEED
FURNACES
BLOWERS
FILTERS
WASHERS
Air Conditioning • Heating Equipment
WRITE FOR ATTRACTIVE DEALER PROPOSITION
ELECTROGAS FURNACE CO.
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MILWAUKEE GAS SPECIALTY CO.
MILWAUKEE ★ WISCONSIN
GAS VALVE SERIES 500
ELECTRIC SWITCH SERIES 600

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FIRST CHOICE

IN NATIONWIDE AGA COMPETITION

Specified in 15 out of the 50 plans published in the Architectural Forum's recent AGA Competition—

Specified by 6 of the 24 prize winners—

Specified in one of the $1000 prize-winning plans of both major divisions—

Specified by more top ranking contestants than any other make of furnace—

AGA Prize Winners Specify Payneheat

• CLASS I •

$1000 Prize
Alden Becker

$200 Prize
Frederick E. Emmons, Jr. and Donn Emmons

• CLASS II •

$1000 Prize
Hugh Stubbins and Marc Peter, Jr.

$300 Prize
R. C. Levanas

$200 Prize
Malcolm P. Cameron and Howard A. Topp

$200 Prize
Yukio Kako

Here is proof that Payneheat is the outstanding choice among the nation's architects. Architects who have reputations to uphold. Architects who are pioneering tomorrow's designs and tomorrow's home appliances.

Precision constructed for more than 25 years by an accepted leader in the gas heating industry, Payne Furnaces are a constant reminder of the superiority of gas.

Payneheat is GAS heat—at its best.

Floor Furnaces · Unit Furnaces
Forced Air Units · Consoles
Winter Air Conditioning Units
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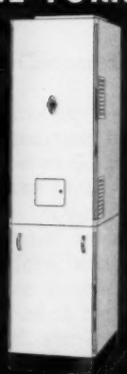
THE IDEAL FUEL GAS

Payne

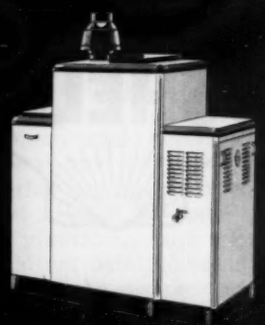
FURNACE & SUPPLY CO., INC.

BEVERLY HILLS • CALIFORNIA

PRIZE WINNING PAYNE FURNACES



Payne "FAU" (Forced Air Unit) heats in winter — ventilates in summer. Occupies only four square feet of floor space. Operates from kitchen or service porch.



Payne Beverlyair Unit — the latest contribution to year 'round home comfort. Heats, cleans, circulates the air and automatically controls humidity.

Propane
Butane

ANNOUNCEMENT

Propane and Butane for enrichment of manufactured gas, for mixing with air for gas-air systems, or vaporizing directly for straight vapor systems are now available for shipment in tank cars from our Martinez and Wilmington, California, refineries. Inquiries covering your requirements are invited. Write:

Liquified Gas Department
Shell Oil Company
Shell Building, San Francisco

SHELL OIL COMPANY

Developing Liquefied Gas Load Beyond the Piped Gas Mains

● **B. D. GEROY, general manager, Illinois Bottled Gas Co., Chicago, Ill., in a paper, "Bottled Gas Beyond the Gas Mains," delivered before the 33rd Annual Convention of the Midwest Gas Association, St. Paul, Minn., April 11-13, 1938.—(Abstract by G A S).**

IN merchandising Dri-gas, the Illinois Bottled Gas Co. has two objectives to accomplish. One is to secure aggressive, well financed dealers with whom it can co-operate intensively. The other is to take the story of the advantages of its product, such as convenience, cleanliness, speed, reliability, economy, etc., to prospective buyers with the intention of directing them to local retail dealers who will sell and service them.

To secure retail dealers and keep them constantly active, the company maintains a staff of field representatives, each of whom constantly recovers his territory, making personal contacts and lending such merchandising and servicing assistance as may be required. After securing the proper dealer, efforts are made to maintain his efficiency, as each such dealer represents a definite investment.

Probably 60 per cent of the selling appeal to prospective customers is made on the basis of gas as the most desirable fuel, rather than on the competitive selling of a particular brand in preference to the product of some other liquefied petroleum gas distributor. This appears to be a general approach among liquefied gas distributing companies.

Promotional Campaign

Practically every medium of advertising is used, but chief reliance is placed upon radio and direct mail. Mailing lists are selected with greatest care, using names of prospects furnished by dealers, supplemented by others obtained from sources that reveal financial position. These lists are then broken down geographically, according to their proximity to various dealers.

The heaviest advertising drive comes in the early spring. At this time of year, the average farm or small town housewife is weary of old-fashioned or inefficient fuel. She is filled with the spirit of spring cleaning and modernization. The company plays towards those two conditions, striving to show her that its fuel is cleaner, more efficient, and that it will free her from much of the drudgery and heat she has long associated with summer in her kitchen.

Constant effort is expended to make advertising as graphic as possible. Each year the story is told more completely by pictures, and less by words. The backbone of the company's advertising campaign this year is a 16-page, tabloid-size rotogravure mailing piece, in two colors. This mailing piece thoroughly covers all of the desirable prospects for the product in the selling area of each dealer. It directs its readers to see their dealer for complete particulars about the product and the services he can give.

The cycle of sales effort is completed by providing dealers with merchandising helps to tie-in with the principal advertising job that has been done for them. Each dealer is supplied with a complete sales kit which includes colorful envelope stuffers, punchy display signs, window display materials, newspaper advertising mats and various other supplementary advertising materials such as elaborate catalogs showing the complete line of appliances available, as well as the company's Dri-gas operating units in several sizes.

In addition to the annual spring advertising drive, further sales promotional efforts are made at various periods throughout the year. Sales records give a close check on dealers' business conditions, and, when a slackening of orders is indicated, the situation is remedied by suitable merchandising activity. This may take the form of an attractive premium offer, a trade-in sale, or other special event type of appeal that gives the dealers logical reason for applying greater sales pressure to prospective customers. Such special promotional activities are thoroughly supported by local advertising material supplied to dealers, including newspaper advertising mats, window display material, circulars, etc., to assure close local tie-in with the general merchandising scheme.

The company uses, also, the device of sales contests among its dealers. Frequently, special selling conditions are met by inaugurating bonus offers, which serve to stimulate the dealers' selling efforts by offering additional reward for exceptional effort. To keep such activities imbued with the spirit of competition, prizes for top producers may be offered in the form of cash, or perhaps expense-paid trips to the company's annual dealer convention.

Cooperative Plan

In discussing bottled gas activities with the manager of a gas utility company a few weeks ago, the writer was told that the utility company was giving some thought to supplementing present main business with bottled gas. The idea being, of course, to protect future potential gas load lying beyond present mains. Not being familiar with service and delivery costs in bottled gas operations, he was under the impression that such activities could be made profitable, plus, of course, the protection that would accrue to his company against encroachment from his electrical competitor. After reviewing our company's cost analysis data—which details delivery expense, capital investment, amortization of cylinders and product liability obligation, he agreed readily that his company would necessarily have to secure at least 300 active customers, requiring an initial expenditure of at least $15,000, to make the undertaking profitable. Such a load, of course, could not be attained at a selling expense commensurate with profit returns until those 300 active customers had been secured.

In view of these facts, the Illinois Bottled Gas Co. has found quite a few operating companies interested in de-

veloping an arrangement of some kind with an ably financed local bottled gas distributing company, whereby both operations could be associated, insofar as they apply to prospective customers located just beyond the termination of the natural or manufactured gas company's mains.

One proposal of this kind is a co-operative merchandising plan, under which the gas company's retail organization would apply the same effort in promoting gas cookery among its prospects beyond the gas mains as is now used in selling gas service to customers within main limits. As part of such a promotion, the metropolitan retail appliance sales divisions would sell outlying prospects whatever appliances they needed and could afford to buy. Appliance purchasers would then be referred to the cooperating bottled gas distributor in the locality, from whom the customer would purchase or lease a bottled gas operating system.

This proposal has a number of advantages that work to the interests of both companies:

1. It definitely assures metropolitan companies of additional gas customers, as soon as they find it desirable to extend mains. It is stated, "definitely," because bottled gas service is naturally more costly than main service. Domestic cooking load for the liquefied gas industry during 1937 averaged $3.00 per month as compared to the $2.25 per month for metropolitan service. At this difference in operating cost, it is the rare exception when a bottled gas customer is not willing to pay a small conversion charge to have his bottled gas range converted for metropolitan service.

2. It reduces the chance of such potential prospects purchasing electric ranges, which would place them in a position where they would be lost for a considerable period of years as gas customers for your companies.

3. It enables metropolitan appliance sales divisions to secure a profit on the sale of appliances that would not be possible if those prospects bought electric ranges without any competitive activity.

4. It definitely places the metropolitan company in a position to lock the door on electric competition without any capital investment.

From the point of view of the liquefied gas industry such an arrangement would accomplish two purposes.

1. Metropolitan company promotional efforts would aid in making bottled gas convenience better known and more readily acceptable as the ideal fuel where there is no city gas.

2. It would give liquefied gas distributing companies additional temporary gas loads at very little added delivery expense, because the local distributor probably has anywhere from one to a dozen customers within a mile radius of the prospect's home. This would enable the rendition of bottled gas service at only a fraction of the expense that would be involved should metropolitan companies attempt to render the same service by dispatching trucks on a special delivery trip for the small return in profit involved.

In conclusion it must be stated that the relationship between metropolitan and rural companies henceforth should be one of mutual cooperation rather than one which might appear as competitive. In the final analysis, both types of service are promoting the one good idea—and that is *"Gas Service."*

■ ■

H. W. Wickstrom Presents Butane Topic Before S.C.M.A.

"The Practical Application of Butane and the Orifice Meter as Used to Control Air Mixtures," was the topic of Harold W. Wickstrom, consulting engineer, in filling the featured speaker's role before the August meeting of the Southern California Meter Association. The meeting was held in Huntington Park, Calif., with Harry A. Faull, Southern Counties Gas Co., presiding.

"Crime in Politics" was the topic of George Stahlman of the Los Angeles District Attorney's Office, and his remarks were received with interest by the Association's members. Mr. Stahlman was presented through the courtesy of the Daniel Orifice Fitting Co., Los Angeles.

■ ■

New Stargas Cooking School Held at Farmers Branch

The Lone Star Gas Co., Fort Worth, Texas, staged the first New Stargas cooking school at Farmers Branch School, Texas. The demonstrations were conducted by Albertine Berry, home economics director, Stargas department. R. F. Foster, Stargas engineer, was in charge of arrangements.

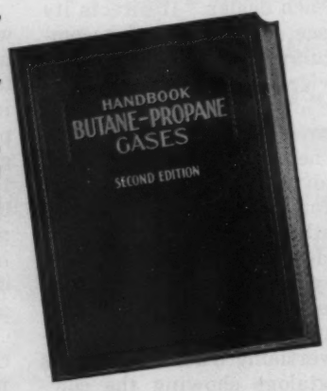
The first day's demonstration featured an entire meal cooked on top of the range while the second day Miss Berry demonstrated oven canning for fruits and vegetables. Only a range and gas refrigerator were put in actual use, but the display included a water heater and heating equipment.

■ ■

Ukiah, Calif., To Change To Butane Gas for Fuel

Ukiah, Calif., will effect a changeover from manufactured to butane-air gas within the next two months, according to a recent decision of the city council of that community. The action of the council followed a six months period of investigation of butane plants in southern Oregon. The approximate cost of the changeover to a municipal butane plant will be $5000.

HANDBOOK
BUTANE
PROPANE
GASES
SECOND EDITION
375 pages
$5.00 per copy, plus postage



CONTENTS: Use in internal combustion engines: Design & Installation of Storage: Supply from Petroleum Refineries: Engineering Data on the Lower Olefins: Domestic Appliance Testing and Utilization: Economical Comparisons with Coal, Oil, Electricity, Producer Gas, Manufactured Gas: Town Plants: Manufacture from Natural Gas: Special Uses: Volume Correction Factors: Supplements & Revisions: Transportation: Use with other Gases: Analysis & Testing: Properties of Mixtures: Bottled Gas Distribution: Bibliography: Central Plant Directory: Catalogue Section.

2nd Edition Handbook...$5.00
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Published by publishers of GAS *The NATURAL Gas Magazine*
810 S. Spring St.
Los Angeles, Calif.

Shell Oil Co. Announces New Source of Liquefied Gas

SHELL Oil Co., Los Angeles, Calif., announces a new source of supply of butane and propane at the company's Martinez refinery on San Francisco Bay, in addition to the Wilmington refinery facilities. A. C. Maynard is manager of the liquefied gas department.

Shell Co. has provided special tankage and equipment for the recovery of these products and the necessary tank cars for delivery to customers. All shipments are carefully tested prior to departure from the refinery to insure uniform quality.

Shell Oil Company entered the liquefied gas business in the late 20's, distributing propane in steel cylinders under the name of "Shellane Tank Gas." Shellane tank gas is distributed throughout the company's operations on the Pacific Coast.

■ ■

Worthington Bottled Gas Plant Nears Completion

Worthington Gas Inc., Minn., has announced that the installation of machinery at the company's new bottled gas plant in Worthington has been completed. The storage tank was put under a pressure test for the first time on August 4. The Worthington concern will purchase Philgas wholesale from the Phillips Petroleum Co. and distribute the gas locally. On the completion of the new plant, gas will be available in the counties of Pipestone, Murray, Cottonwood, Nobles, Jackson, Rock, Minn.; and Lyon, Osceola, Dickinson, Iowa.

■ ■

Federal Tax Law Is Covered In New Publication

Prentice-Hall, Inc., New York, has recently published a new 117-page booklet, *Federal Tax Law with Explanatory Digest*, covering the Revenue Act of 1938. Included in the explanatory digest is information as to how the taxpayer may avoid the payment of unnecessary taxes. The booklet also contains the text of the tax law verbatim with a summing up of changes in the law and their effect upon taxable income and the taxpayer. The federal tax calendar from May 1, 1938, to April 30, 1939, is also included.

■ ■

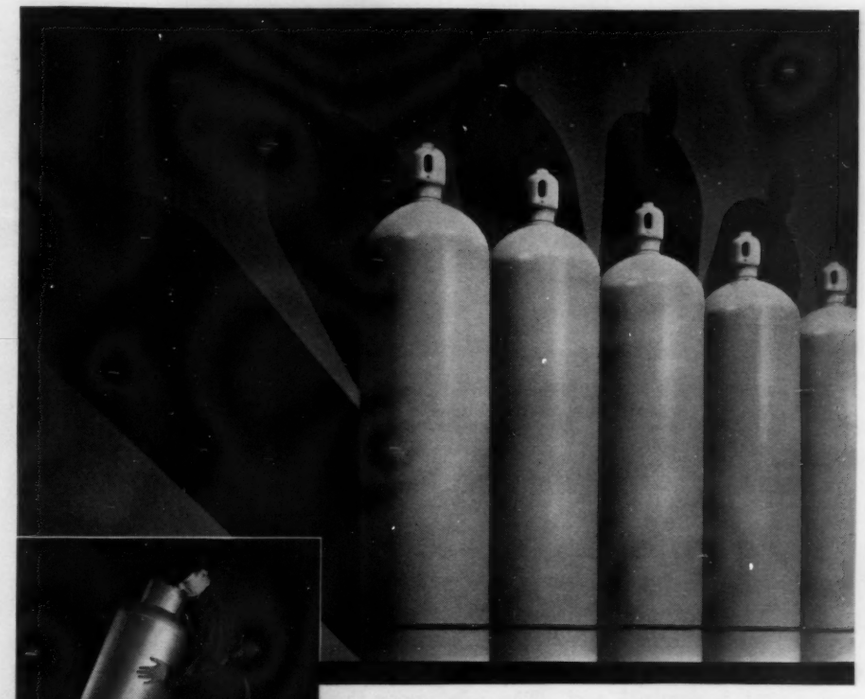
Gas Lines Permit Granted In Los Angeles County

Supervisors of Los Angeles county, Calif., granted a permit on August 1, to the Lomita Gasoline Co. to construct two natural gas lines across the Los Angeles river bed. The gas lines, one a 16-in. dry gas line and the other a 10-in. wet gas line, are to serve a new well in the area south of the Long Beach, Calif., interurban line. The lines will also be available for future developments in that region.

■ ■

Canadian Compressed Gas Manufacturers to Meet

The Canadian section of the Compressed Gas Manufacturers' Association will hold its regular autumn meeting in Ottawa, Canada, September 9-10.



HACKNEY ASSURES UNIFORM STRENGTH AND CAPACITY

THE continued specification, year after year, of cylinders made by Pressed Steel Tank Company proves the satisfactory service which they are performing in the gas industry. Hackney's more than 35 years of precision manufacturing experience enable the production of cylinders dependably uniform in strength and capacity.

The carefully guarded proper balance between maximum strength and minimum weight assures low cost shipping and handling. There are several types of economical, efficient Hackney containers for the storage and shipping of Propane and Butane and Propane-Butane mixtures.

Be sure to have **complete** information about Hackney containers. Write for full details today, there is no obligation.

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PRESSED STEEL TANK COMPANY

208 S. La Salle St., Rm. 1185, Chicago — 1363 Vanderbilt Concourse, New York
666 Roosevelt Building, Los Angeles — 1463 South 66th Street, Milwaukee

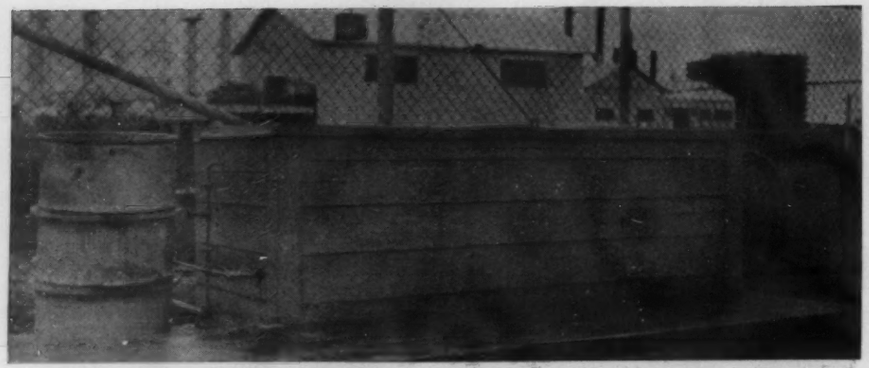
Containers for Gases, Liquids and Solids

INDUSTRIAL GAS BOILERS

Plain tubular..... ¾ to 10 H.P.
Water Leg tubular..... 5 to 45 H.P.
HE Flueless ..... 1 to 18 H.P.

ASME Code for 100 lbs. S.W.P., also for higher pressures.
Non-electric Low Water Cut-offs for all types of boilers.

P. M. Lattner Mfg. Company
CEDAR RAPIDS IOWA



This butane refrigerated ice plant built and owned by employees of the Skelly Oil Co. has an ice freezing capacity of 400 lbs. per day.

Oil Co. Employees Use Butane As a Refrigerant to Manufacture Ice

UTILIZING butane as a refrigerant, Skelly Oil Co. has made it possible for employees at its Lyman, Okla., specialty plant to make their own ice at a nominal cost. The apparatus used for this purpose consists of a large wood tank, lined with metal to form a brine container, into which 25-lb ice cans are inserted for freezing.

Butane line leads from the two specialty fractionating columns accumulator drum, where butane is received upon condensing, to this refrigerator, with an expanding valve placed near the tank. Two-in. pipe coils surround the space designed to receive the cans, and the vat filled with a saturated solution of common salt water. A small air line leads from plant compressors to the tank, which connects below the normal water line to provide agitation of the saline water.

The butane line, upon emerging from the coils in the tank, is connected to the plant intake system to provide vacuum for increased expansion of the butane. The material used in constructing this ice plant was paid for by employees of Skelly Oil Co., with the company doing construction. The cost of each employee participation was approximately $1.50 as the original investment, and additional costs of a few cents each year for salt supplies.

The plant is operated by employees on duty, who observe whether or not it is functioning properly, supply the butane for refrigeration and look after agitation of the salt water. Individual employees, who own cans in the ice plant see to it that their cans are filled with water, and pull the cans when ice is needed in their homes. In this way, each participating employee is assured of an adequate supply of ice for home consumption, with only the small initial investment, and the trouble of filling and pulling cans.

Sixteen cans comprise a full working unit, with as many employees participating in the benefits. The cost of operating the unit to full capacity of 400 lbs. daily is absorbed in the consumption of 200 gals. of butane expanded through the refrigerating coils. This butane is not wasted, but recovered again through the gas stripping system, and it is said that the addition of even this small amount of butane returned to the raw gas supply aids in the recovery of propane. The ice plant, which has been in use for two seasons, stands out in the weather and requires only a casual inspection by operators each day.

■ ■

L.P.G.A. Sets October Date For Eastern Section Meeting

The Eastern section of the Liquefied Petroleum Gas Association is planning to meet in Atlantic City during the week of October 10, coincident with the annual convention of the American Gas Association.

Mark Anton, Suburban Gas Company, Newark, N. J., is chairman of the eastern section and, according to F. R. Fetherston, secretary of the L.P.G.A., the meeting will take up a full day, and is expected to be well attended.

■ ■

Midwest Section of L.P.G.A. To Meet September 22-23

The Midwest Section of the Liquefied Petroleum Gas Association will hold its semi-annual fall meeting at the Hotel Bismarck, in Chicago, Ill., September 22-23. The program for the meeting will include technical papers pertaining to the liquefied petroleum gas industry.

REDUCES 100 POUNDS TO MEDIUM OR LOW PRESSURE

Fulton Toggled Reducing Regulator

CF

The tank or transmission line may carry 100 pounds or more of pressure and you can reduce it to medium or low pressure in your distribution system with the Fulton Toggled Reducing Regulator. Can be adapted for either natural or manufactured gas. Also for by-product coke oven gas. For reversing furnaces, equipped with oversize valves. Gives definite and sure control. Circular 2573, on request.

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PARSONS ENGINEERING CO. Los Angeles, Calif. San Francisco, Calif.
OR ANY JOBBER

Photo by courtesy of Ryan Aeronautical Company.

Ryan Planes, modern descendant of Lindbergh's "Spirit of St. Louis," also made in San Diego.

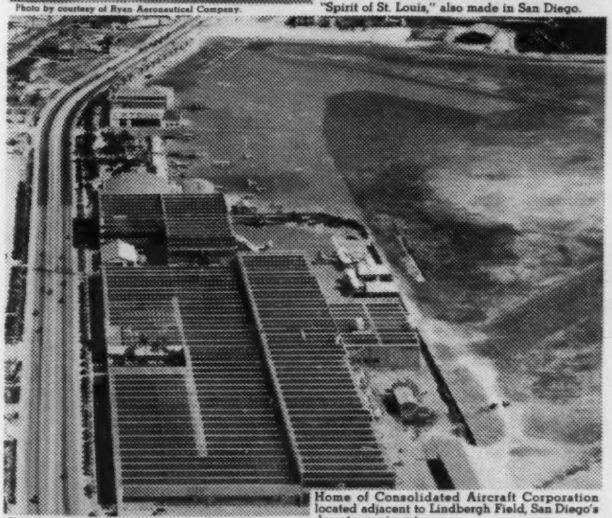

Photo by courtesy of Consolidated Aircraft Corporation.

Home of Consolidated Aircraft Corporation located adjacent to Lindbergh Field, San Diego's downtown airport.

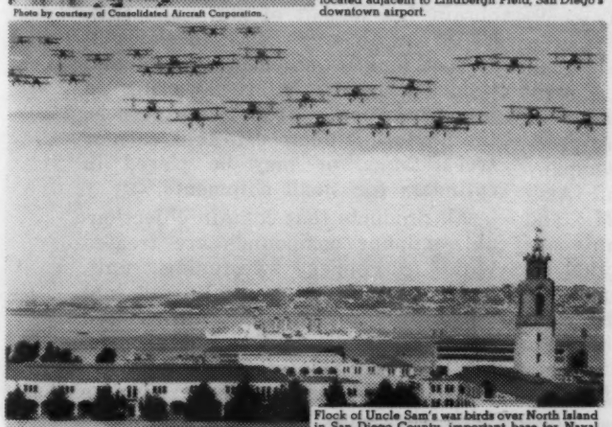

Photo by courtesy of San Diego Harbor Department.

Flock of Uncle Sam's war birds over North Island in San Diego County, important base for Naval Aviation.

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Air Capital OF THE WEST

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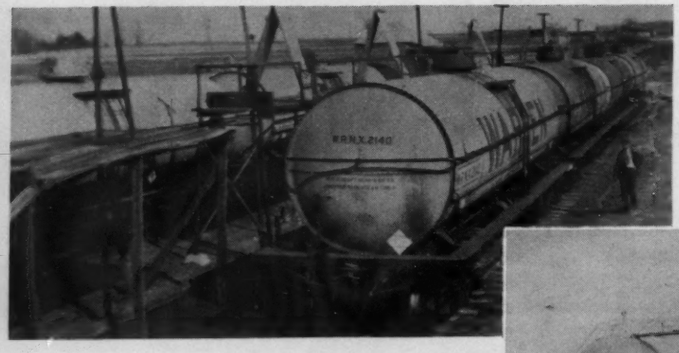

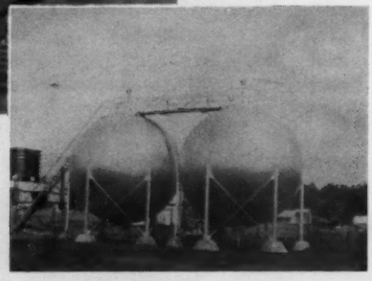

ABOVE: A Warren Petroleum Corp. railway car loading rack. AT RIGHT: Hortonspheres for storage of liquefied petroleum gases.

Warren Petroleum Adds to Facilities For Production of Liquefied Gases

By J. C. ALBRIGHT Staff Correspondent

SIXTEEN years ago Warren Petroleum Corp., Tulsa, Okla., began operating as a brokerage institution, handling natural gasoline, buying from manufacturers and selling to refiners for blending and other purposes. During the past few years, the company expanded from a brokerage to a manufacturing business, and now operates plants in several of the oil field states, where not only natural gasoline is manufactured, but also special products are produced, including propane, butane, and mixtures of both these hydrocarbon fractions.

In order to expedite delivery and sales of liquefied petroleum gases, the company established a butane division during the early part of 1938, which department handles all products the company manufactures as well as purchases from other producers of natural gasoline.

The most recent development is a plant at Aransas Pass, Texas, which has a capacity of 110,000,000 cu. ft. of natural gas daily from which all products are produced that are marketable, such as various grades of gasoline and mixtures of lighter products. Other plants of this company are located at Fittstown and Ardmore, Okla.; Monument, N. M.; and Galva, Kan. All of these plants are equipped to separate any fraction required, producing butane-propane in various percentages for drilling wells in isolated sections where natural gas is not available, and to supplant other fuels, such as fuel oil, Diesel fuel and ordinary gasoline.

The plant at Galva, Kan., constructed quite recently, is equipped with three fractionators, which cut any grade of gasoline required, and including any of the mixtures required. Gasoline which is processed in these columns is manufactured by a combination of compression and absorption, utilizing eight-cylinder angle type engines which require only 10 x 14 ft. floor space, enabling this company to install 2600 hp. in an unusually small building. About one-fourth of the gas handled in this plant is processed at well pressure, with the remaining amount passing through these compressors, which provides a production of about 11,000 gals. of butane-free gasoline daily.

Butane and propane-butane mixture are stored in long, underground storage vessels, 150 ft. in length, installed in pairs and placed in an excavation with a three-foot cover to obtain full benefit of soil insulation. These vessels were made in shops in 75-foot. lengths, shipped to Galva, and welded in place before lowering in the excavation. From these vessels, the product is pumped to tank cars or truck tanks, or may be placed in cylinders for small shipments.

All products that contain objectionable sulphur compounds are treated with a copper sweetening unit, equipped with a tangential nozzle into which compressed air is introduced in required amounts to obtain reaction. It has been stated that the reaction of mercaptans in the gasoline with the copper treating compound

In the new construction field
ALL GAS KITCHENS
are selling houses!

The public has been quick to demand the new standards of performance, convenience and economy set by the latest gas appliances. That's why an increasing percentage of all new homes are completely gas equipped —for cooking, water heating, refrigeration and house heating. To the prospective purchaser, such equipment is a sign of merit. To the contractor, it is a real sales builder.

●

SOUTHERN CALIFORNIA GAS COMPANY
SOUTHERN COUNTIES GAS COMPANY

is essentially the oxidation to the mercaptans to the corresponding disulphides and the reduction of the cupric ion to the cuprous state. Cuprous chloride formed in the reaction is soluble in a solution containing high concentration of chloride salts. The hydrochloric acid evolved in the reaction is also retained in the solution, and is said to be essential to the process, because, it is stated, cuprous chloride and the hydrochloric acid are converted back to cupric chloride by oxidation with air introduced into the gasoline stream in controlled volume.

■ ■

Gas Division of Oklahoma Utilities Group to Meet

Plans are now under way for the Gas Division meeting of the Oklahoma Utilities Association, to be held September 26, in Oklahoma City. According to W. Lee Woodward, Zenith Gas System, Inc., Alva, Okla., this will be the first strictly gas meeting to be conducted by the association for several years.

E. Holley Poe, secretary, A.G.A. Natural Gas Division, will speak before the convention.

The tentative convention program includes the following papers: "Present Profitable and Unprofitable Gas Load and Potential Profitable Gas Load," by Lyman H. Bell, Central States Power and Light Corp., Tulsa; "Leakage and its Effects," Harry W. Pitzer, Southwestern Light and Power Co., Chickasha; "Employer and Employee Relationship," Oakah L. Jones, Oklahoma Natural Gas Co., Tulsa; "Promoting Merchandise Sales Through Dealer Cooperation," Carter Mullaly, Hales-Mullaly Co., Oklahoma City.

A noonday luncheon will be held with J. Y. Wheeler, president, Oklahoma Utilities Association, presiding.

■ ■

Industrial Sales of Citizens Gas and Coke Show Increase

Since 1929 the gas send-out to industrial customers of Citizens Gas and Coke Utility, Indianapolis, Ind., has increased 80 per cent. At the present time gas consumption of industrial users, including foundries, packing houses, railroad shops, hosiery and garment mills, and printing plants, amounts to 25 per cent of the utility's total gas sales. At peak operation one of the largest Indiana industries uses 16,000,000 cu. ft. per month, which is equal to the combined consumption of about 6600 average homes.

■ ■

Southern Union Financial Offices Have New Location

The Southern Union Gas Co. and subsidiaries, Arkansas Western Gas Co., New Mexico Gas Co., New Mexico Eastern Gas Co., and Southern Union Utilities Co. announced on August 1, the removal of their financial offices to 135 So. La Salle St., Chicago, Ill. Ross Byron, vice-president, will be in charge of the new offices.

John N. Shannahan, Utility Executive, Succumbs

JOHN N. Shannahan of Indianapolis, president of Midland United and Midland Utilities holding companies, Chicago, Ill., died August 16 of heart disease. He was 66 years of age.

In 1933 Mr. Shannahan became president of the Midland United Co. in Indianapolis. At that time he also became an executive of the Midland company's power, light, gas and electric railway subsidiaries, operating in Indiana, Illinois and Ohio. Mr. Shannahan also headed the Indiana Railroad and Chicago, South Shore and South Bend Railroad.

In 1934 Mr. Shannahan was appointed chairman of the Northern Indiana Public Service, West Ohio Gas and Indiana Hydro-Electric Power and president of six other subsidiary companies.

Born in 1872, Mr. Shannahan was a graduate of Rensslaer Polytechnic Institute in 1894 and began his career as a batteryman with the New York Central and Hudson River Railroad. From 1916 to 1926 he was president of the Newport Gas and Electric Co.

■ ■

Condensation Corp. Transfers Mosher To London, Ontario

Ralph S. Mosher secretary of Condensation Engineering Corp., Chicago, manufacturers of Vitroliner chimney liner and the Howle Heat Extractor, has been transferred to London, Ontario, to take over the management of a subsidiary company operating in that territory under the name of Condensation Engineering Corp., Ltd., of Canada. Company headquarters are maintained at 184 Horton Street, London, from which point gas companies in the Dominion of Canada are served.

R. S. MOSHER

■ ■

Natural Gas Supply Co.'s Properties in Okla. Sold

John B. Nichlos, a producer in the Chickasha and Cement fields, Okla., has purchased the properties of the Natural Gas Supply Co., Chickasha. The company handles gas from wells in the Cement field and delivers it to other companies through the eight-mile line running east to the Chickasha field.

Mr. Nichlos expects to use the line to deliver gas from the Cement field to the Southwestern Light and Power Co., the Lone Star, Oklahoma Natural, Consolidated Gas and others.

■ ■

Permit Issued For New Gas Measuring Station in Lawton

The city engineer's office in Lawton, Okla., has recently issued a permit to the Consolidated Gas Utilities Corp., Oklahoma City, Okla., for the construction of a gas measuring station in that community. The new station will be 28 ft. by 38 ft. and will cost about $600.

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THAT ARE
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Made from finest Quality Metals, carefully machined to exacting specifications. Each thoroughly tested, before leaving the factory, for ease of operation and freedom from leakage.

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AS FRIENDLY AS YOUR HOME
OFFERS EVERYTHING YOU HAVE THE RIGHT TO EXPECT IN A RESORT HOTEL
Each member of the family will find diversion . . . Concerts and dinner music by artists of the Phila. Orchestra • Luncheon served guests in bathing attire on our open air dining terrace • Restricted beach • Bathing from rooms • Dancing • Bar • Sundecks • Social Director • Kindergartner • Noted cuisine.
Rates for Room, Bath, Meals, Based as Low as (on a weekly stay, per person, 2 in a room) $6.30 DAILY
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1938
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"...in my home, as in my factory
I DEPEND ON GAS"
EXPERIENCED home maker, successful business woman, owner and general manager of the nationally-known Cubbison Cracker Co., (Mrs.) Sophie C. Cubbison of Los Angeles speaks authoritatively on housekeeping, as well as on commercial baking. ★ Significant therefore is her choice of "all four" gas appliances for her home, and of gas fuel exclusively for the huge bake ovens of her modern plant. ★ Mrs. Cubbison sums up her faith in gas fuel with business-like directness: "I can depend on gas and it is always economical." ★ These same qualities—plus unrivaled speed, cleanliness and control—mean better results for you in COOKING, HOUSE HEATING, WATER HEATING and REFRIGERATION. ★ It's sensible, as well as modish to have an all-gas home!
★ Winter evenings invite luxurious relaxation in the cozy warmth of this forced-air gas "wall heater," cleverly built-in. ★ Reminiscing, Mrs. Cubbison recalls starting her baking business as a bride, in the kitchen of her first small house.
★ The interesting Cubbison view-home, atop Mount Washington in Los Angeles, is of Mexican hacienda design, faithfully simulating even the scars of age, in the form of "cracked" plaster and exposed bricks. (As a matter of fact, the house is quite new and completely modern, including gas heating, cooking, water heating and refrigeration.)
★ Note how old-time hacienda atmosphere is carried out in the kitchen, with yesterday's alcove for today's gas range. ★ The same dependable gas fuel helps maintain Cubbison factory capacity of 10,000 packages a day, including Mella Toast, Melbetts, Melba Cookies, Zwieback, Nutrimet Wafers and other famed Cubbison products—personally developed and marketed by Mrs. Cubbison.
OUR QUICK, CLEAN, ECONOMICAL SERVANT
WOMAN MANUFACTURER RECOMMENDS GAS FOR INDUSTRY AND HOME
★ ★ ★ ★
Sunset Magazine, California
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★ ★ ★ ★
Sunset Magazine, California Parent-Teacher and California Federation News are carrying this message to a quarter-million western women, who are interested in such careers as Mrs. Cubbison's (manufacturing food products) and in such unique homes as her Mexican-style house.
★ Through the medium of this unusual series of advertisements, the gas companies of the West are telling a factual sales story that helps all branches of our industry.

Machine Coating and Wrapping

Stationary or Traveling

The Stationary Type Pipe Coating Machine, illustrated above, applies a single or double coating of NO-OX-ID and NO-OX-ID-IZED Wrapper to pipe from ¾ in. to 12 in.

A Traveling Type Machine applies NO-OX-ID hot on pipe from 6 in. up.

Both machines greatly increase the facility of application and the economy of the use of these Dearborn Products. Inquiries invited.

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Gas Proration Recommended for Hugoton Field, Kansas

PRORATION of gas production in the major Hugoton area, extending into six southwestern Kansas counties, was recommended by independent and major company witnesses in a corporation hearing in Hugoton, July 22. A formula taking account of well pressures and acreages, with minimum weight to open flow, was suggested by Marin Lee, consulting engineer representing Joe Denham, Dodge City operator, who charged gas wastage and unratable taking exist in the field as now operated. Similar recommendations as to formula were made by John Handley, representing the Northern Natural Gas Co.

J. H. Page, director of the gas section of the state conservation division, testified that of 265 wells producing in the six-county area, 28 have no pipe-line connection which has resulted in drainage of gas across lease lines. Mr. Page said ratable taking is practised by the purchasing companies as to wells on their own lines, but not as between pipe line companies. Of the 13,000,000,000,000 cu. ft. of reserves originally existing in the 2,380,000 acre gas producing area, Mr. Page maintained that approximately one per cent of the volume had been withdrawn.

■ ■

A.G.A.E.M. Issues Sales Plan Book for CP Ranges

The Domestic Gas Range Division of the Association of Gas Appliance and Equipment Manufacturers has recently issued a Sales Plan Book to aid gas companies and maunfacturers in the promotion of the CP ranges, which 18 manufacturers have been presenting to the public since August 1.

The Sales Plan Book contains suggestions for both the advertising and merchandising of the CP range. Included in the publication are samples of direct mail pieces, newspaper and magazine advertisements, as well as window display material to be furnished on request by the A.G.A.E.M. sales promotion department. Twenty suggestions for effective dealer cooperation and sales tie-in material adaptable for the dealer's usage are also contained in the new book.

■ ■

Free Vegetable Peelers Advertise Simmer Burners

Customers of the Dallas Gas Co., Texas, received free vegetable peelers, during July, with instructions for using the simmer burners on modern gas ranges. The peelers, designed for attachment to paring knives, were attached to cards, one side of which bore instructions for the use of the utensil while the other explained the value of the simmer burner for cooking vegetables.

■ ■

Edmore, Mich., Approves Natural Gas Franchise

The Consumers Power Co., Jackson, Mich., has been granted a natural gas franchise by Edmore, Mich. By a vote of 148 to 79, Edmore citizens approved the franchise on July 18. Work on the pipe line and the installation of pipe through the town will soon commence.

A.G.A. Statistics Show Increase In Domestic Gas Customers For June

PAUL RYAN, chief statistician of the American Gas Association, reports that domestic gas customers totalled 15,898,100 on June 30, an increase of 265,900 over the number reported on the same date in 1937. Statistics for the month of May reveal an increase of 1.6 per cent in domestic customers over May, 1937.

The quantity of natural gas used in generating electric power during the six months, ending June 30, amounted to 76,751,300,000 cu. ft., an increase of 2.2 per cent over the corresponding period in 1937.

In California commercial gas sales showed an increase of 18.2 per cent for June, 1938, over June of the preceding year, and an increase of 1.7 per cent for the first six months of 1938 as compared with the same period of the preceding year. Revenue from California commercial sales for the month of June showed an increase of 8.2 per cent over June, 1937. For the month of May, 1938, domestic sales in California showed an increase of 17.7 per cent over May, 1937, and commercial sales an increase of 19.3 per cent.

Natural and manufactured domestic gas sales showed a notable change in Arizona and Nevada with an increase of 15.5 per cent for June of this year over June, 1937 and an increase of 7.1 per cent for the six month period, ending June 30, over the same period in 1937. During the month of May domestic sales in these states increased 15.6 per cent over May, 1937, with an increase of 6.4 per cent for the five month period, ending May 31. Commercial sales for the month of May increased 16.0 per cent over the same month of the previous year and for the five month period showed an increase of 2.7 per cent.

Statistics for Kansas for May showed one of the largest rises in commercial gas sales with an increase of 26.7 per cent for the month over May, 1937, and an increase of 13.8 per cent for the five month period, ending May 31, over the same period in 1937.

■ ■

Lone Star Gas System Quotes 1937 Tax Statistics In Pamphlet Form

The Lone Star Gas System has recently quoted in pamphlet form statistics relating to the corporation's annual tax bill. In 1937 the Lone Star System paid a tax bill of $2,086,-257, an amount almost equal to the $2,201,00 pecan crop produced by the State of Texas in 1935. This amount was also equal to half the value of the entire 1935 wheat crop harvested in the 58 Texas counties in which the Lone Star system operates.

The system's 1933 tax bill amounted to $527 for each person in its employ while in 1937 taxes amounted to $719 per employee. In 1936 Lone Star paid a tax bill of $4,164 per day, Sundays and holidays included, but by 1937 this figure had mounted to $5,715 per day.

The fact that each year the system is required to file more than 27,000 different reports indicates a complicated routine of government regulatory and taxing agencies with more than 54 different kinds of city, county, district, state, and federal taxes paid each year by system companies. It has been revealed that the 1937 Lone Star System taxes amounted to approximately $9 for every domestic and commercial customer served by the system.

■ ■

Kentucky Natural to Take Gas From Panhandle Eastern Co.

The Panhandle Eastern Pipe Line Co., Kansas City, Mo., has contracted with Kentucky Natural Gas Corp., Owensboro, Ky., to sell a minimum immediately of 2,500,000 ft. of gas daily and a maximum six years hence of 10,000,000 ft. daily. The 15-year contract covers substantial additional sales of so-called "interruptible" gas. The gas will be resold by the Kentucky company to its markets in Indiana and Kentucky.

■ ■

Italian Buses Use Compressed Gas

In order to become less dependent on imported motor fuel, 306 motor buses in Italy are now being driven by engines powered by compressed natural gas. There are now under construction 417 vehicles, built to use this type of fuel.

LEADERSHIP

● In every line of business there is always a leader—always one company that ranks above all others in achievements, experience and quality of product. This is true in the Gas Control field. Reynolds, with forty-five years' experience, is the oldest and largest exclusive maker of Gas Control equipment.

The constant introduction of new regulators is proof of Reynolds' pledge always to improve its products. For Reynolds is not content to rest upon any past achievements. Reynolds is jealous of its position and determination to continue its leadership — to the end that Reynolds will always be the one best source of supply for Gas Control equipment.

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High Pressure Service House Regulators — Straight Lever Type—Models 0-10-20 series; Toggle Lever Type —Model 30 series.

Low Pressure Service or Appliance Regulators.

District Station Regulators, Single or Double Valve—Auxiliary Bowl and Automatic Loading Device optional.

High Pressure Line Regulators—Pilot Loaded—Pilot Controlled.

Toggle Type Regulators—Single Valve, Double Valve, Triple Outlet.

Seals—Dead Weight or Mercury . Back Pressure Valves . Automatic Quick Closing Anti-Vacuum Valves . Automatic Shut-off Valves . Lever Operated Valves . Louver Operated Device . Atmospheric Regulators . Vacuum Regulators.

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Meet your friends of the Gas fraternity and enjoy

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Application for Lone Star Financing Filed with SEC

THE Lone Star Gas Corp., Wilmington, Del., on July 25 filed application with the Securities and Exchange Commission for approval of the company's proposed $31,000,000 financing program to refund $29,600,000 of bank loans and bonded indebtedness, according to an announcement by L. B. Denning, Lone Star president.

Mr. Denning has declared that the corporation contemplates the issuance and sale of $20,000,000 of 15-year debenture bonds and the placing of $11,000,000 of installment bank notes. Total assets of the Lone Star Corp. and subsidiaries, as disclosed in the system's annual report for 1937, amounted to $155,000,000, and net income available for stockholders after deducting interest charges of $1,200,000 amounted to $6,800,000.

Indebtedness to be refunded includes $13,500,000 of bank loans, $8,000,000 of five per cent to six per cent bonds of Council Bluffs Gas Co., Dallas Gas Co., County Gas Co., and Texas Cities Gas Co., and $8,100,000 of six and one half per cent and seven per cent preferred stocks of Lone Star Gas Corp. and Dallas Gas Co.

■ ■

New Kansas Gas Firm Is Chartered by State

The Rex Gas Co., Chanute, Kan., formed for construction of a pipe line from western Kansas fields to the eastern part of the state, was chartered by the state of Kansas on August 4. Capital was listed at $1000. According to Lloyd Burton, organizer of the new company, the route of the gas line from western Kansas has not yet been definitely determined, but it is expected that soon the lateral lines will extend to the Albert-Otis field. The main source of supply will be the Hugoton gas field.

The new pipe line will be approximately 554 miles long and will serve the cities of Emporia, Topeka, Leavenworth, Kansas City, and Chanute. According to Mr. Burton, the purpose of the new company is to serve only large industries; the company will not enter the domestic gas service field.

Named as incorporators of the new firm were Walter L. Sidwell, Victor H. Martin, H. D. Kors, Howard Kuhn, T. A. Morgan, Walter Kuhn, H. W. Loy.

■ ■

Mississippi Co. Awards Free Fishing Trips to 58 Dealers

The Mississipi Power and Light Co., Jackson, has announced that 58 appliance dealers were eligible to attend the two-day Free Fishing Fiesta at Gulfport, Miss., on July 29, held at the expense of the Mississippi Company. The free trips were awarded to those dealers in company territory having the highest percentages of sales in the recent 1938 Profit Parade sales campaign sponsored by the company's commercial department.

■ ■

United Gas Pipe Line Co. Plans $800,000 Gas Line

The United Gas Pipe Line Co., Houston, Texas, according to late press reports, is taking the right-of-way for a proposed gas pipe line from the Katy gas area, on the Waller and Harris county lines, to a point near Clinton station, northeast of Houston.

Approximate cost of the project will be about $800,000, it is reported. Planning to begin operation as soon as possible, the company will use 10-, 12-, and 16-in. pipe for the new line.

■ ■

Natural Gas Is Converted Into Useful Chemicals

According to a recent American Petroleum Institute announcement, a $4,000,000 project is being planned by one of the country's largest chemical corporations for the conversion of Texas natural gas into synthetic alcohol, antifreeze solution, and other useful chemicals.

Equipped with a complete display of modern gas appliances, the Evanston Gas Appliance Store of the Public Service Co. of Northern Illinois was opened recently. The store is one of the first in its territory to install gas air conditioning equipment.

Broiling - IMPORTANT FACTOR IN - GP Range

Certified performance broiler requirements are readily obtainable by using the WELSBACH PATENTED RADIANT BURNER. Broiler temperatures can be reached within the required time with minimum burner input—Effective broiling area increased.

The WELSBACH RADIANT BURNER produces the penetrating INFRA RED RAYS —Assures uniform and quicker broiling—Enriches food flavors.

This burner available for license to responsible manufacturers.

Write for details.

Welsbach Radiant Broiler Burner

WELSBACH COMPANY

GLOUCESTER CITY, NEW JERSEY — BRANCHES IN CHICAGO AND SAN FRANCISCO

Since 1887, Pioneers in the Manufacture of Gas Appliances

GREENLEE

Here is the Solution to Your Pipe Pushing Problems

Hydraulic PIPE PUSHER

One man, standing in a comfortable position, can exert a pressure of 40,000 pounds on the pipe clamp.

Here is a real improved pipe pusher that permits one man to stand in a comfortable position and send pipe where it is wanted, simply by pumping the handles. It is compactly built, easy to handle and simple to set up and operate. Because of its time and labor-saving features, it is often able to pay for itself on the very first job.

The Greenlee Hydraulic Pipe Pusher is self-contained. It operates on a notched steel base, which permits making a push of from 4 to 7 feet, depending on the length of base used, without changing the pipe clamp. When it reaches the front end of the base, it is pushed back to the opposite end, and the quick-acting clamp is then reset. Pumping the handles sets up a pressure within two oil cylinders to push the pipe. This provides a smooth-acting, powerful mechanism that is flexible and exceptionally simple. It will push pipe up to 4-inch, has eight speeds for varying soil conditions and will exert a maximum pressure of 40,000 pounds on the pipe clamp.

WRITE TODAY for COMPLETE DETAILS

GREENLEE TOOL CO., 1700 Columbia Ave., ROCKFORD, ILLINOIS

Natural Gas is Restored to Depleted Oklahoma Sands

By PAUL R. TAYLOR
Division Manager
Stone & Webster Service Corporation

THE storage of surplus natural gas in depleted gas sands during periods of low consumption is an important conservation measure, and a boon to distributing companies. Most of these companies procure their gas both from natural gas reservoirs and by purchase of gas that is a by-product of oil production and natural gasoline extraction. Due to the use of natural gas for heating, the greatest demand for it is during the winter, while the greatest supply of the by-product is available during the summer, frequently at a relatively low cost. Stored at low cost in underground reservoirs favorably located with relation to large markets, it reduces the load on long transmission line systems during periods of peak demand and may obviate the need for heavy investment in new pipe lines.

Practically 100 percent of the gas stored in an exhausted field may be recovered if the field is protected against offset drilling, the formation is impervious to leakage, and the old wells are tightly sealed. This is shown by the following experience of a Stone & Webster supervised company.

Early in 1936, Oklahoma Natural Gas Co. examined a small field in Tulsa county from which most of the gas had been exhausted. The original rock pressure in this pool had been 560 lbs. per sq. in. Several paying wells had been drilled and approximately one-half billion cu. ft. of gas had been removed from the field before the pressure had declined to about 100 lbs. per sq. in. A series of dry holes showed that the pool was geologically closed and defined the limits of the pool which covered an area of nearly 160 acres.

In order that the entire area occupied by this reservoir might be covered by contract, the company secured storage rights upon approximately 360 acres. In addition, a regular five year commercial oil and gas lease was executed. The gas remaining in the reservoir that could be removed if the pressure were reduced to 50 lbs. per sq. in. was calculated and the owners reimbursed. After the necessary rights had been acquired all the abandoned wells were checked for proper plugging, and two wells were left for the purpose of introducing and later extracting gas. During the summer of 1937 gas which could be bought at a low price from gasoline extraction plants was injected into the depleted sands with the aid of a compressor. The reservoir was filled rather slowly in order that observations of the resulting pressure could be carefully noted. Approximately 77,000,000 cu. ft. of gas were injected into the reservoir and the pressure increased to 232 lbs. per sq. in. Starting some two months later, during the winter months, withdrawals were made in accordance with market demands in Tulsa. By the end of the winter nearly 79,623,000 cu. ft. had been withdrawn, about 2,500,000 cu. ft. in excess of input, and the pressure of the reservoir still was 50 lbs. per sq. in. above the pressure at the time the injection of gas was begun. The reason for this increase in pressure is not known exactly, but it may be due to encroachment of water in the reservoir space sometime after starting the injection of gas.

Due to the fact that a relatively small amount of equipment was necessary to handle the gas, and no great expense was involved in securing the storage rights and placing the wells in condition, the total cost per M c.f. for storing and extracting this gas was below the area's standard field price.

■ ■

Three-Judge Federal Court Upholds Texas Sour Gas Law

In an opinion filed in Austin, Texas, July 25, a three-judge federal court upheld the law authorizing proration of Panhandle field sour gas production.

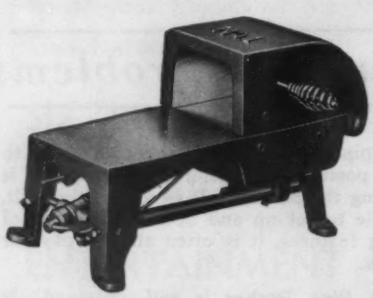
The case testing the law was brought by the Henderson Co. The court upheld the statute and denied the Henderson Co. an injunction. The case was held open, however, pending further experience with the proration formula now effective in the field.

■ ■

Warehouse Installs Gas Engines for Power

The State Fuel Supply Co., Oklahoma City, has recently installed natural gas service for power generation in the Chickasaw Elevator and Warehouse in Blanchard, Okla. A 40 hp. gas engine and two 40 hp. auto engines are used.

JOHNSON NO. 1 Bench Furnace Gives Powerful, Uniform Heat at Low Cost



Here is a sturdy, efficient cast-iron furnace for heating soldering coppers up to 6 lbs. per pair and for heat-treating small carbon steel tools and parts. No blower or forced air blast required. The firebox is lined to maintain uniform temper, and the patented curved top returns the flame over the work. The exclusive JOHNSON Direct Jet Bunsen Burner saves fuel and gives tremendous heat. Equipped with shut-off valve and pilot. Write for catalog today.

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225 Bush Street, San Francisco, Calif. 30 Rockefeller Plaza, New York, N. Y.

So. Calif. Gas Co. Extends Service to Two Towns

CONSTRUCTION of a main pipe line extension from Southern California Gas Co.'s natural gas system at Visalia in the San Joaquin Valley to supply the adjacent towns of Ivanhoe and Woodlake was scheduled to begin August 15. It is estimated that approximately 94,000 lineal ft. of three- and two-in. piping will be required for the main extension. Total piping, including mains, laterals and services will probably exceed 114,000 ft. Estimates set the cost of the project at more than $60,000.

Surveys made by gas company engineers show a total of approximately 690 possible consumers in the area. Of these 558 are evenly divided between Ivanhoe and Woodlake, and the balance are in territory contiguous to the main pipe line. Schools in each town have already signed for gas service.

Over 40 per cent of the potential consumers had signed for gas by the middle of August, according to word received from George A. Porter, manager of the Southern California Gas Co.'s San Joaquin Valley division, headquarters at Visalia.

■ ■

Lake Mills, Iowa, Awards Natural Gas Franchise

The citizens of Lake Mills, Iowa, at a special election, held on August 16, cast a vote of 442 to 165 favoring the granting of a natural gas franchise to the Peoples Natural Gas Co., affiliate of Northern Natural Gas, Omaha, Neb.

Natural gas to be served in Lake Mills will be transported by Northern Natural Gas Co. lines from the Panhandle of Texas and southwestern Kansas to Minneapolis, Minn., and to northern Iowa where the 24-in. diameter pipe is reduced to 20- and 16-in. diameter.

The nearest booster station to Lake Mills is at Ventura, Iowa, where line pressure is 450 lbs. per square inch. Construction work for the Lake Mills changeover will be done by the J. J. Conner Construction Co. Residents of this community formerly consumed wood, oil, and coal for fuel.

■ ■

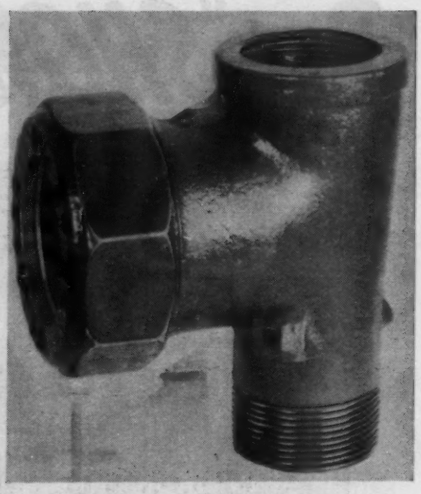
Macnick Company To Be Mid-Continent Agent

The Macnick Company, Tulsa, Okla., has, since August 20, been acting as Mid-Continent agent for the American Recording Chart Co., Los Angeles, according to J. W. Dunn, manager of the Los Angeles company. C. E. Nicholson, president, and J. B. McGaughy, vice-president of the Macnick Company, are known in the territory for their work in developing the Emco-McGaughy integrator.

■ ■

Owen B. Evans Resigns as Philadelphia Engineer

Owen B. Evans has recently resigned as engineer of works for the Philadelphia Gas Works Co., Pa. His resignation was due to ill health. Mr. Evans had been with the company since 1904.



S. R. Dresser Super Service Tee

S. R. Dresser Co. Announces New Line of Street Tees

S. R. Dresser Manufacturing Co., Bradford, Pa., is offering a new line of Super Service Street Tees, Style 90. The unit is designed to mitigate failures in gas distribution systems.

One of the advantages of the unit is the flexible branch outlet, which absorbs stresses and pipe leverage due to movement of either main or service. Another advantage is the elimination of threads. The tees do away with exact lining up of pipe, work starting threads, turning of long pipe lengths, exact pipe lengths, and large excavations.

These street tees are now available in one-, one and one fourth-, one and one half-, and two-in. ID straight sizes and in 10 reducing sizes.

■ ■

San Diego Gas and Electric Starts Work on New Building

Construction operations are now under way on the new $20,000 building for San Diego Gas and Electric Co., Calif. The building permit was taken out in July.

The new building will house the company's sales and administrative departments. Modernistic in design, the walls of the new structure will be of cement construction trimmed in terra cotta. Dimensions are 50 ft. by 88 ft. The building will have large display windows, and the front section of the floor space will be devoted to merchandising and sales.

■ ■

Pipe Line Co. Files Articles of Incorporation in Wyo.

The Rocky Mountain Pipe Line Co. has recently paid a filing fee of $1315 for its state charter in Wyoming when articles of incorporation were filed with the Wyoming secretary of state. Company assets are listed as $1,300,000.

■ ■

Joseph R. Lees Succumbs

Joseph R. Lees, senior collection clerk, North Philadelphia District of the Philadelphia Gas Works Co., subsidiary of United Gas Improvement Co., died suddenly July 4, after 40 years of service with the company.

Homestead "Woodfires" and "Coalfires"

using gas as the fuel are the ideal fireplace heaters.

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Your customers want them.

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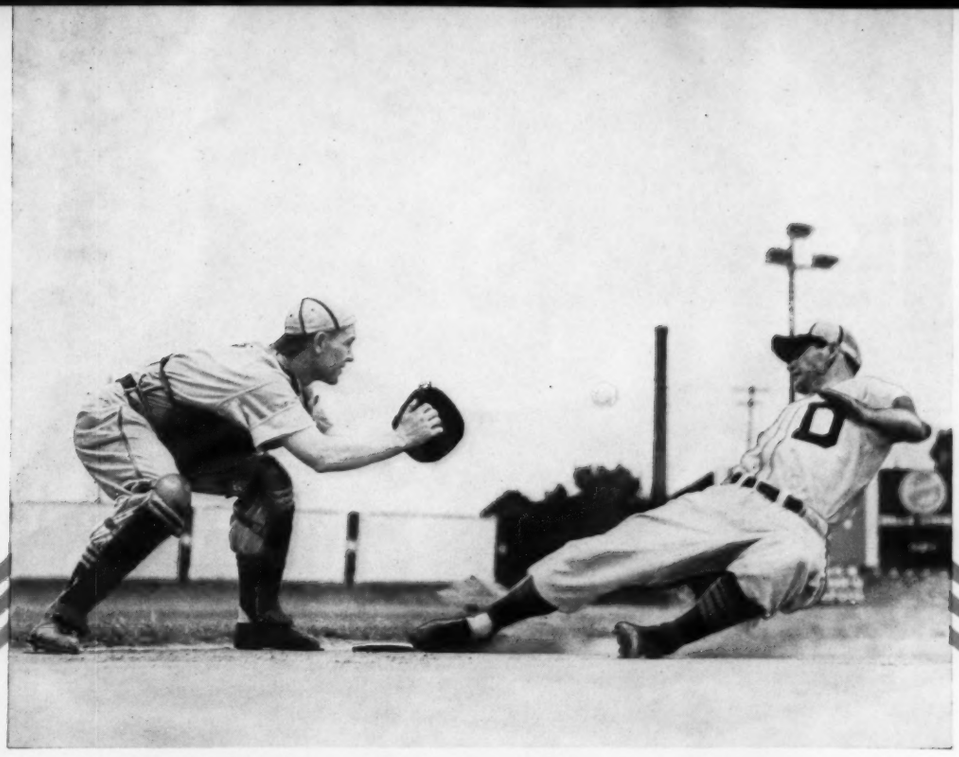

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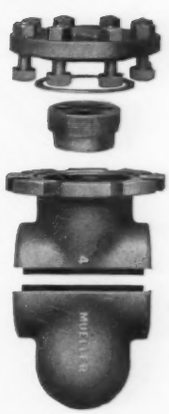
When it is necessary to isolate a section of the distribution system to make repairs, extensions, tie-ins, etc., the SAFE thing to do is to use Mueller Pressure Control Fittings and Equipment The design and principle of these fittings and equipment is such that they insure a positive shut-off at all times. They need not be installed until the occasion demands and then they are installed at the exact location desired at a cost less than any type valve. Inconvenience and expense attending a shut-down of the line is eliminated as service continues without a seconds interruption or loss of head. Workmen are not exposed to the danger due to high pressure gas and since a positive shut-off is assured, welding operations may be carried on with absolute safety



Weld Type

The equipment necessary is very simple and easy to use. Write today for full details as to the operation and use. Address Dept. 838.

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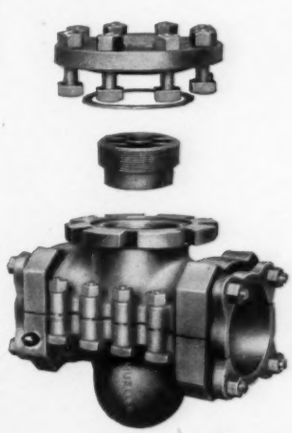
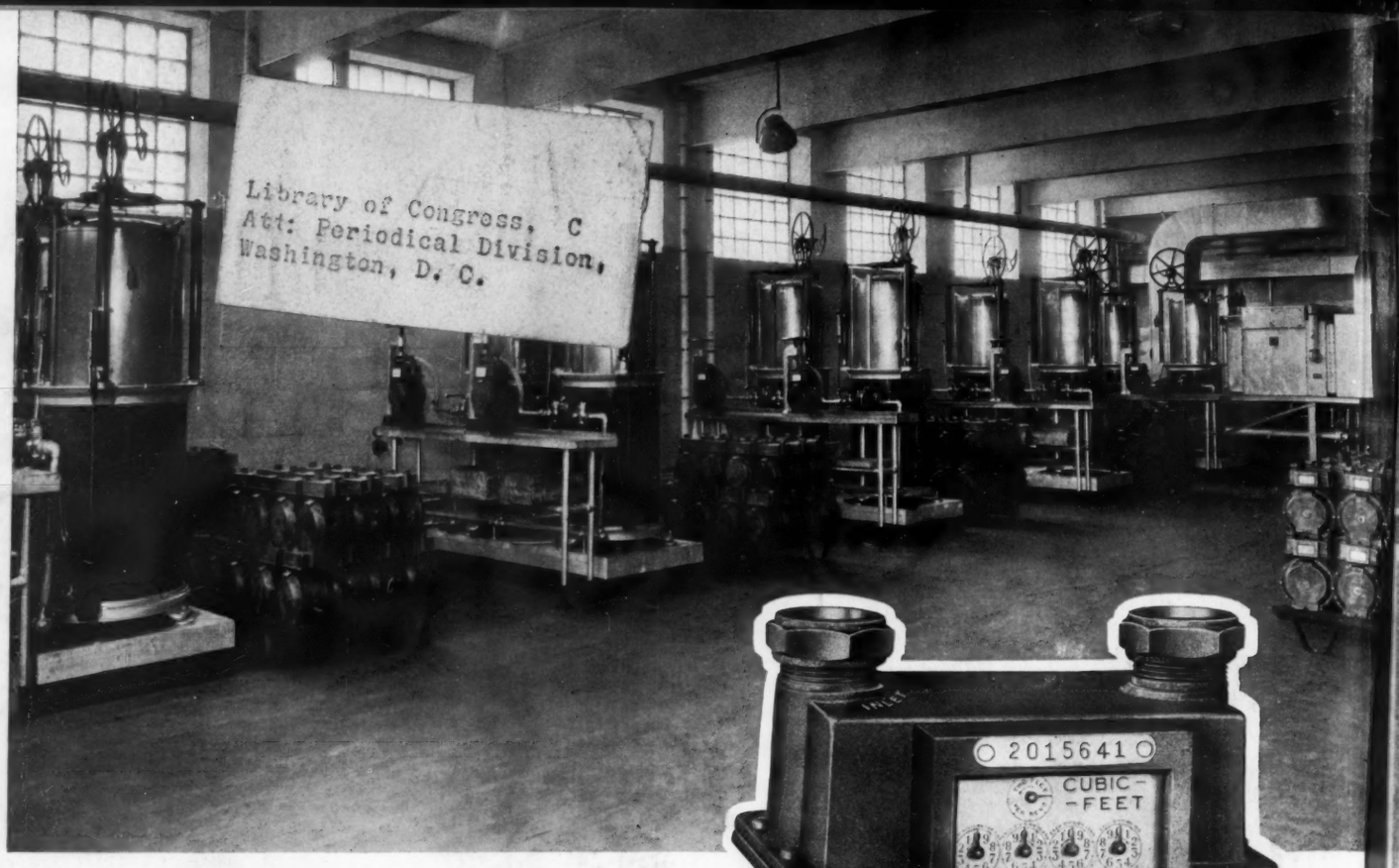


Mechanical Joint Type

MUELLER

GAS SERVICE EQUIPMENT

Modern Proving of Gas Meters



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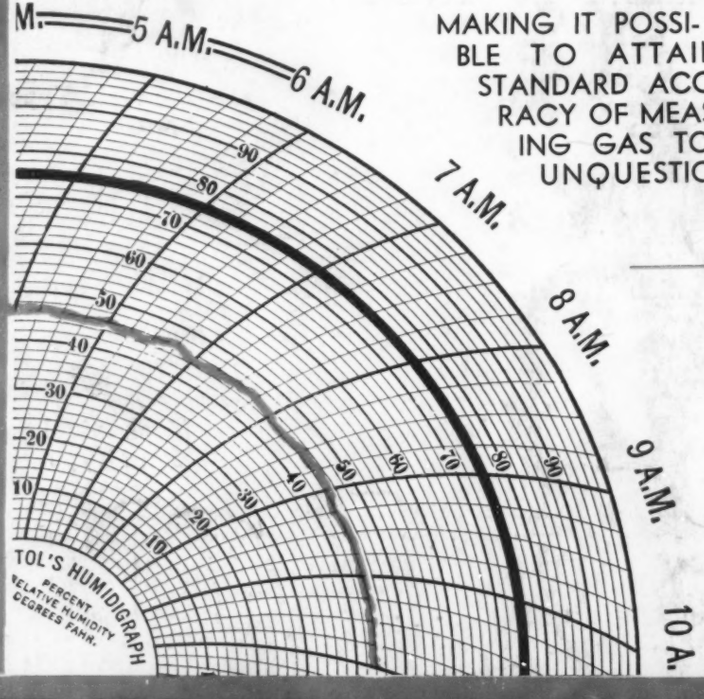

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